APPENDIX B:
HMMH TECHNICAL REPORT REGARDING NOISE

Draft Supplemental Technical Report on Noise: Winter Use Plan Final Supplemental Environmental Impact Statement

for the
Yellowstone and Grand Teton National Parks
and
John D. Rockefeller, Jr. Memorial Parkway

HMMH Report No. 295860.360

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

This document presents additional documentation of technical analysis and results performed in support of the National Park Service's Final Supplemental Environmental Impact Statement on the Winter Use Plan for Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr. Memorial Parkway. This document refers to (and avoids repeating) the technical information provided in the noise study technical report that was prepared for the Final EIS.[1]

1.1 Updated over-snow vehicle measurements

On February 6, 2002, HMMH conducted vehicle pass-by measurements of many different over-snow vehicles on behalf of the National Park Service. The purpose of the program was to supplement and update the initial data collected in 2000 for the Winter Use Plan EIS, and it provided the opportunity to measure precisely the noise emissions from a wide variety of over-snow vehicles, including the new design snowmobiles with four-stroke engines. Section 2 details the vehicle measurement procedures and results.

1.2 Addition of a modified sound propagation model

For the Final SEIS, a modified sound propagation model has been used in addition to the model used previously in the EIS and Draft SEIS analyses. With the modified model, sound levels drop off at a faster rate with distance over snow. The original model represents an estimate of "worst-case" propagation conditions, such as would occur over firm snow with downwind or temperature inversion atmospheric conditions. The modified model represents an estimate of "best-case" propagation conditions, such as would occur over soft snow with calm winds and temperature lapse atmospheric conditions. Results including sound levels and audibility distances for noise from over-snow vehicles are provided for both models to allow comparisons across the FSEIS Alternatives under both worst-case and best-case conditions.

1.3 Report overview

Section 2 of this report provides a detailed description of the updated over-snow vehicle pass-by measurements and results, and the process for selecting the vehicles to represent the Best Available Technology for the subsequent modeling effort. Section 3 describes the methods and selection of the over-snow vehicles to represent best available technology for the modeling. Section 4 describes the changes in the modeling approach and assumptions for this Final Supplemental EIS, as well as providing tables of the model input used to generate the results. Section 5 provides the results of the analysis, in a similar format as provided in the Final EIS and its supporting technical report.

2. UPDATED OVER-SNOW VEHICLE PASS-BY NOISE EMISSION DATA

On February 6, 2002, HMMH conducted vehicle pass-by measurements of many different over-snow vehicles on behalf of the National Park Service, in a cooperative endeavor with several local tour operators, who provided the snow machines for testing, and the Wyoming Trails Program, whose

[1] "Technical Report on Noise: Winter Use Plan Final Environmental Impact Statement for the Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr. Memorial Parkway," Report No. 295860.18, prepared by Harris Miller Miller & Hanson Inc., June 2001.

staff coordinated the pass-bys. Jackson Hole Scientific Investigations, Inc. also collected noise data in the test zone[2]. The purpose of the program was to supplement and update the initial vehicle pass-by data collected in 2000 for the Winter Use Plan EIS. Since the 2002 measurements were significantly more comprehensive, better controlled and more current than the 2000 pass-by measurements, only the data from the recent measurements were used in this study.

2.1 Measurement site characteristics and methodology

The measurement site was an open area on the road just south of the south entrance to Yellowstone National Park. Snow machines traveled on the groomed road; the rest of the site was covered with soft, light unpacked snow 36 in. to 40 in. deep. Skies were clear to partly cloudy, temperatures were 0º F to 10º F, and winds were generally calm or less than 2 mph. Site photos are given in Figure 1 and Figure 2.

Figure 1. Measurement site test zone, from microphone

[2] Daily, J., Raap, K., "Supplemental Over-Snow Vehicle Sound Level Measurements," Society of Automotive Engineers, SAE 2002-01-2766, October 2002.

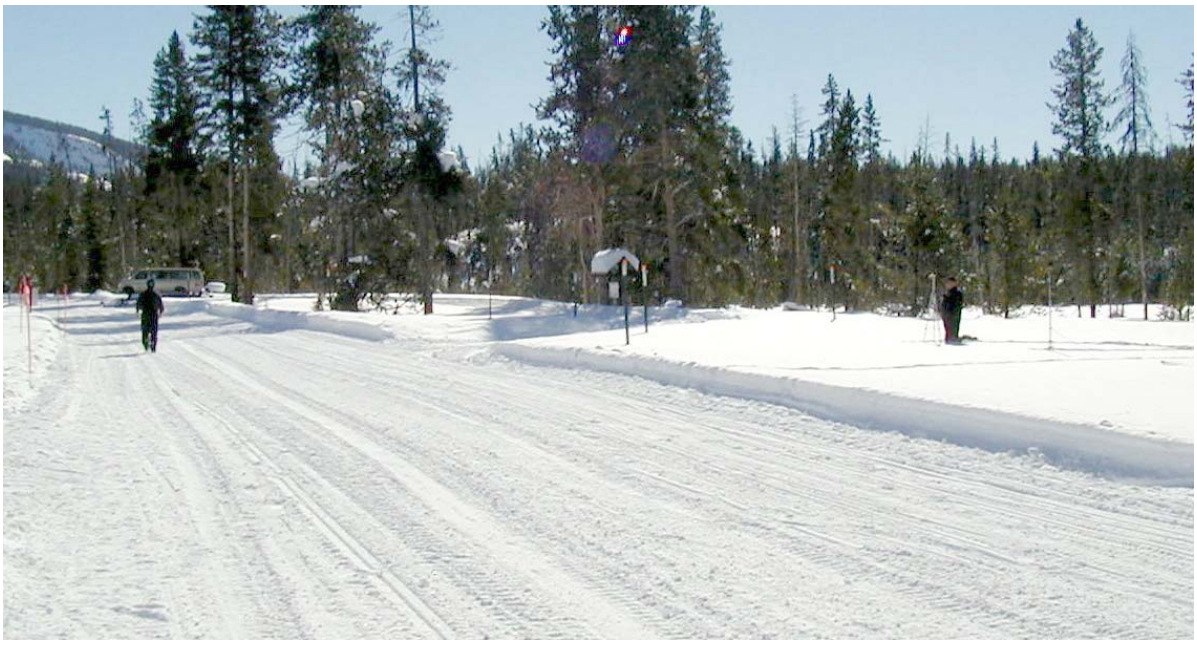

Figure 2. Measurement site, from vehicle pass-by zone

The measurements were conducted in substantial conformance with the SAE J192[3] and J1161[4] measurement standards for snowmobile pass-by noise measurements. Sound level meter "fast" response was used both for consistency with J192 and because many of the vehicle pass-bys were at high enough speeds to require *fast* response for accurate readings. (J1161 recommends *slow* response, but pass-by speeds are limited to 15 mph. Fast response has an averaging time of 1/8 second, while the averaging time is 1 second for slow response.) The snowmobiles were run for four constant-speed pass-bys, two in each direction, at each of three targeted speeds: 20mph, 35mph and 45mph. Snow coaches were run similarly, but at target speeds of 20mph and 30mph. A calibrated traffic radar gun measured the actual speed of each pass-by. In addition to these constant-speed tests, the full-throttle acceleration test specified in J192, and idle measurements were also performed.

Noise emission data were collected with the vehicles operating in constant-speed, cruise conditions. Since snow machines are operated mostly under cruise conditions while traveling in the parks, those conditions are needed for developing the emission levels needed for modeling purposes.

HMMH's measurements were conducted with ANSI Type I (precision) instruments including microphone (B&K 4189), preamplifier (Larson-Davis 900B), sound level meter/monitor (Larson-Davis 870), sound-level calibrator (GenRad 1987), and Digital Audio Tape (DAT) recorder (Sony TCD-D8). A-weighted sound levels were stored every 1/8 second in the sound level meter; the maximum values for each vehicle pass-by event were taken from that data stream. All events were also recorded on DAT and were processed later to obtain the 1/3-octave band spectrum at the time when the A-weighted sound level reached its maximum.

[3] "Exterior sound level for snowmobiles," Society of Automotive Engineers, SAE J192, SAE Recommended Practice, March 1985.
[4] "Operational sound level measurement for snow vehicles," Society of Automotive Engineers, SAE J1162, SAE Recommended Practice, March 1983.

2.2 Over-snow vehicles measured

New-model snowmobiles with four-stroke engines were tested, including the 660 cc Arctic Cat (2001 and 2002, see Figure 3) and Polaris Frontier 2002 (Figure 4); three vehicles of each kind were tested. Four different models of stock snowmobiles with traditional two-stroke engines were tested, including a 2001 Polaris Sport Touring 550, a 2000 Yamaha Mountain Max 600 (Figure 5), a 2001 Polaris Wide-Track 500, and a 2002 Polaris RMK 800. (A modified Polaris RMK was also measured, but the data for that machine are not included here.) The snow coaches tested included a Bombardier with high exhaust (yellow – see Figure 6), a Bombardier with low exhaust (red Alpen Guide – see Figure 7), a 1998 Chevrolet diesel-powered van conversion with Mattrack treads on each wheel (see Figure 8 and Figure 9), a 1996 Ford gasoline-powered van with Mattracks, and a 1999 Ford gasoline-powered van conversion with skis on the front axle and two long tread tracks on the rear (see Figure 10).

Figure 3. Arctic Cat snowmobile with four-stroke engine

Figure 4. Polaris Frontier snowmobile with four-stroke engine

Figure 5. Yamaha Mountain Max snowmobile with two-stroke engine

Figure 6. Yellow Bombardier snowcoach with high exhaust

Figure 7. Red Alpen Guide Bombardier snowcoach with low exhaust

Figure 8. Conversion van snowcoach with Mattracks

Figure 9. Mattrack tread close-up

Figure 10. Two-track conversion van snowcoach

2.3 Summary of measurement data: A-weighted sound levels

Table 1 provides a summary of the measured maximum pass-by A-weighted sound levels for most of the snow machines that were measured, grouped by vehicle type and target speed. All of the snowcoach data are grouped together in the table. The measurement data in Table 1 show that the median pass-by levels of the two types of four-stroke snowmobiles measured were 3 to 5 dBA quieter than those of the four snowmobiles tested with two-stroke engines, depending on speed. The largest difference is seen at 20 mph, where the median L_{max} value for the four-stroke snowmobiles is 66 dBA, and for the two-stroke snowmobiles is 71 dBA, comparable to the snow coaches. The trends are similar but the differences smaller at speeds of 30 to 35 mph; average emissions of snow coaches were about 75 dBA, two-stroke snowmobiles approximately 74 dBA and four-stroke snowmobiles about 72 dBA.

One observation during the testing of the snow coaches was that 30 mph appeared faster than normal for those vehicles. This observation was supported by comments from some of the snowcoach drivers. Since most of these vehicles did not have functioning speedometers, a passenger operated a Global Positioning System unit to assist the driver in maintaining the target speeds for the tests. The snowmobile drivers used the machines' built-in speedometers to set their speeds for the pass-bys, but as the differences in the target and measured speeds shown in the table indicate, the actual radar-measured speeds were about 10% slower. Therefore, the target speed of 45 mph yielded average speeds of approximately 40 mph.

Table 1. Comparison of measured sound levels of snow vehicle pass-bys at 50 ft, Yellowstone National Park, February 6, 2002

Vehicle Type	Target Speed (mph)	Average measured speed (mph)	Average L_{max} (dBA, fast)	Median L_{max} (dBA, fast)	Highest L_{max} (dBA, fast)	Lowest L_{max} (dBA, fast)	Number of Vehicle Events
Snowcoaches	20	20.9	70.7	71.6	75.8	63.6	24
Four-stroke snowmobiles	20	18.5	66.1	65.9	67.6	64.5	26
Two-stroke snowmobiles	20	18.4	71.0	71.3	73.1	68.9	12
Snowcoaches	30*	29.0	74.8	75.3	80.5	68.8	20
Four-stroke snowmobiles	35	31.6	71.8	71.9	73.1	70.2	22
Two-stroke snowmobiles	35	31.9	74.0	74.2	76.8	71.3	14
Four-stroke snowmobiles	45	40.2	73.1	72.9	75.5	71.3	27
Two-stroke snowmobiles	45	40.3	75.8	76.3	77.2	73.3	14
Four-stroke snowmobiles	Accel	27.4**	73.1	72.7	77.0	69.6	24
Two-stroke snowmobiles	Accel	31.3**	78.7	79.1	80.2	76.2	12

*All snow coaches targeted 30 mph except the gas-powered Mattracks, which targeted 35 mph, but achieved 32 mph.
** Speed measured where vehicle was opposite microphone; an approximate measure.

Figure 11 presents a scatter plot of each of the stock vehicle pass-bys as a function of the actual speed measured by radar. The snowmobiles with 4-stroke engines are grouped separately from those with 2-stroke engines. The snow coaches are grouped into three categories: Bombardier, Mattracks and 2-track conversion van. The two-track conversion van was clearly the quietest snow coach, averaging 65.6 dBA at 20 mph, slightly quieter than the average four-stroke snowmobile. The red Alpen Guide Bombardier snow coach with low exhaust averaged 68.4 dBA. The gas and diesel-powered Mattracks snow coaches were comparable, at approximately 72 dBA. The yellow Bombardier snow coach with high exhaust was also about 72 dBA at 20 to 22 mph, but that test vehicle seemed to have higher exhaust noise levels than other yellow Bombardier snow coaches that passed by during the day. Interestingly, as a group, the two-stroke snowmobiles were the loudest vehicles at 20 mph, but the snow coaches (high-exhaust Bombardier and Mattracks) were the loudest at 30 mph.

It should be noted that much of the noise from some of the snowcoaches (particularly the Mattracks) appeared to be generated from the interaction of the vehicle's treads with the snow, and the snow in the test zone had become fairly rough by the end of the day of testing. The rough snow probably caused the tests of some of the snow coaches later in the day to be somewhat higher in track-related noise levels than they would have been under smoother snow conditions. The snow conditions could also have affected the noise emissions of the later-tested snowmobiles as well.

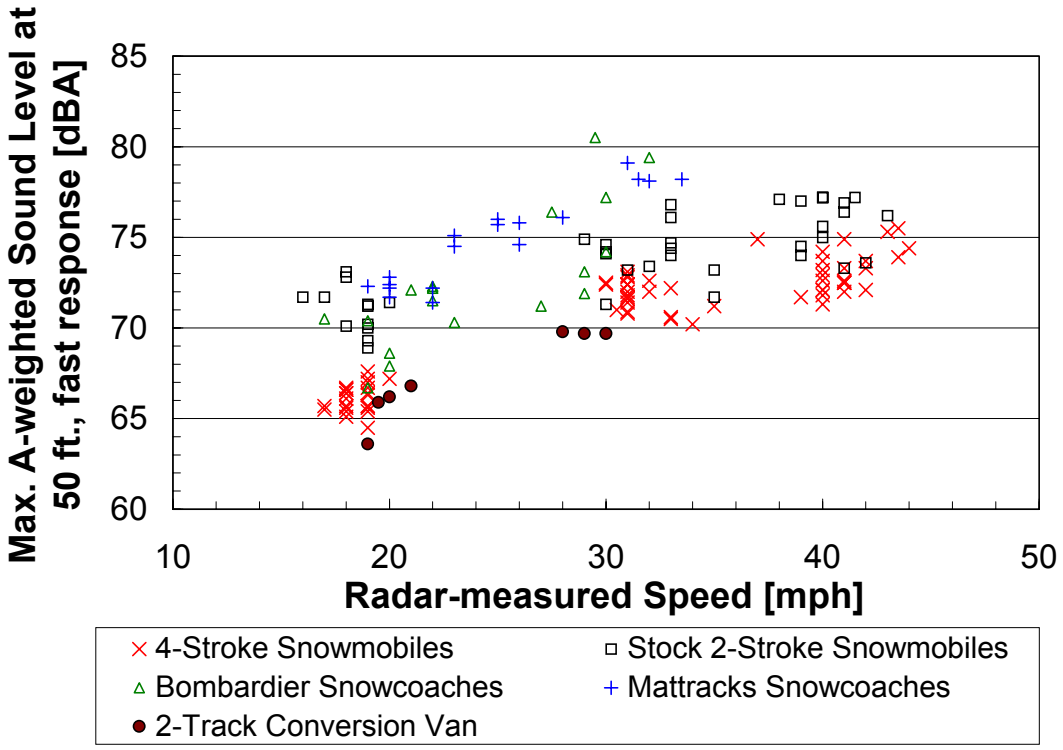

Figure 11. A-weighted Sound Levels of Snow Vehicles versus Speed

2.4 Comparisons of frequency content among vehicles

This section of the report compares the measured spectra of several of the measured vehicles. These are presented to show differences in the low frequency energy and tonal character of various vehicles. These are shown because significant low-frequency energy and prominent tones increase the audibility of noise at long distances.

Figure 12 through Figure 15 present examples of measured spectra for each of the vehicles tested. A typical pass-by was chosen to represent each vehicle; snowmobile spectra are shown for pass-bys at 30 to 35 mph. Snow coach spectra are shown for the 20 mph pass-bys, because the authors judged that to be a typical travel speed for those vehicles. The spectrum shapes for the snow coaches at 30 mph are not substantially different (although the levels are higher).

The spectrum shape for some vehicles is fairly smooth, without clear tonal peaks. The snow coaches that exhibit this characteristic are the 2-track conversion van (shown in Figure 14) and the Alpen Guide Bombardier with low exhaust (shown in Figure 15). Other vehicles exhibit strong tonal peaks perhaps evident of engine firing frequency tones, exhaust resonance or track resonance. For example, the high-exhaust yellow Bombardier shows an engine/exhaust tone at 100 Hz. High-level tones in the low-frequency region below about 250 Hz will make a snow machine significantly more audible at longer distances as compared with machines with smoother spectra or less sound energy in the low frequencies. The diesel-powered conversion van with Mattracks shows a prominent tone at 250 Hz (Figure 14).

The snowmobiles with the lowest and smoothest low-frequency spectra were the (two-stroke) Polaris 550 cc Sport Touring and the Polaris 800 cc RMK. Between the two four-stroke machines shown in Figure 12, the Arctic Cat had a significantly lower and smoother low-frequency spectrum than the Polaris Frontier, which has a prominent 75 dB tone in the 80 Hz 1/3-octave band. Note that while the spectral content of these two machines is very different, the A-levels are nearly the same.

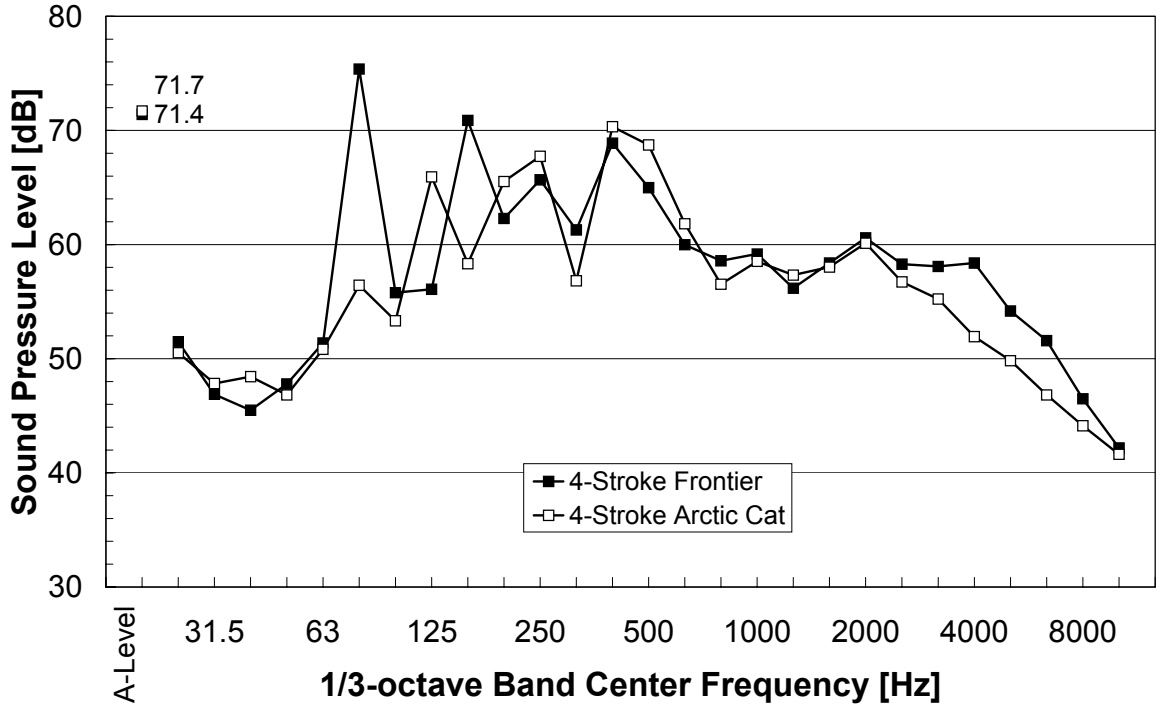

Figure 12. Sound Level Spectra of 4-Stroke Snowmobiles at 30 to 35 mph

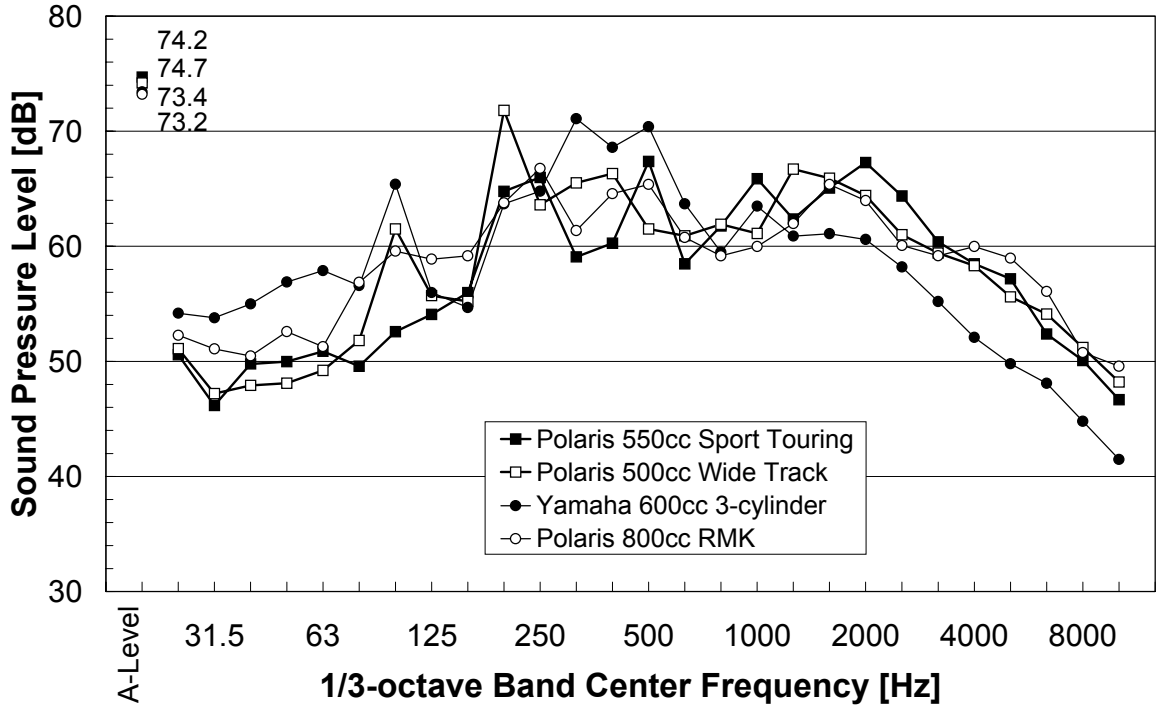

Figure 13. Sound Level Spectra of 2-Stroke Snowmobiles at 30 to 35 mph

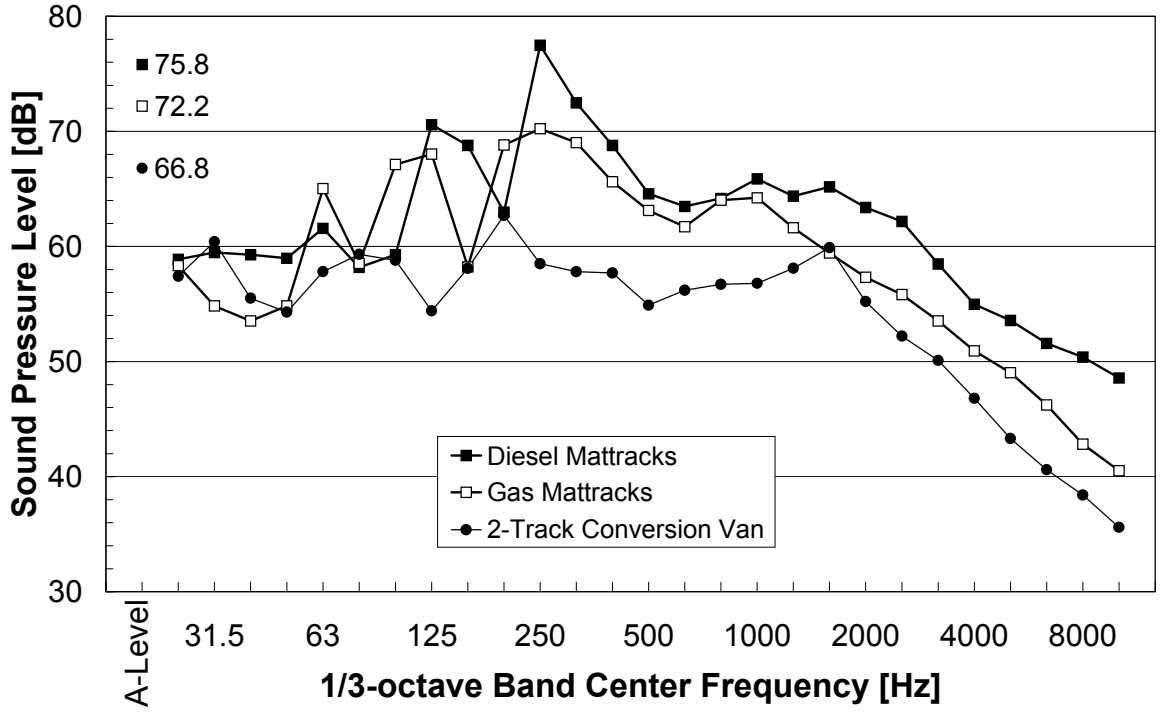

Figure 14. Sound Level Spectra of 4-track and 2-track Snow Coaches at 20 mph

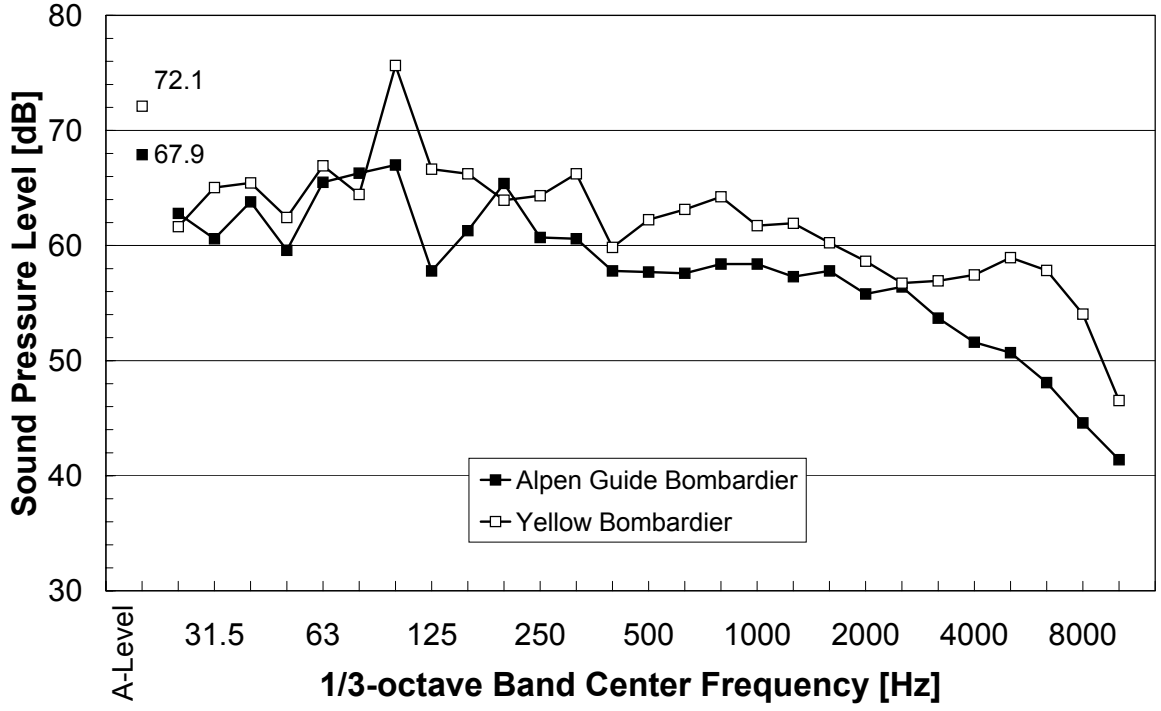

Figure 15. Sound Level Spectra of Bombardier Snow Coaches at 20 mph

3. SELECTION OF VEHICLES TO REPRESENT BEST AVAILABLE TECHNOLOGY

One objective of this study was to identify the most appropriate vehicles among those measured to represent the best available technology (BAT) for both snowmobiles and snowcoaches. The selected vehicles were then used in the modeling for many of the FSEIS Alternatives. This section of the report describes how the measured vehicle pass-by data were used in conjunction with the sound propagation model to select the BAT vehicles.

For purposes of the noise analysis, BAT represents the "quietest" machines. However, the A-weighted sound level from snow machine pass-bys at 50-ft does not correlate well with low-frequency content and tonal character, which are the primary factors that contribute to audibility at long distances. The National Park Service is concerned about the audibility of snow machine noise in the parks, and desired the BAT selection to be driven by audibility of the noise at long distances rather than the more convenient A-level at 50 ft. Therefore, calculation of the distances to the limit of audibility was needed for each of the vehicles measured. First, appropriate spectra to represent each vehicle were developed.

3.1 Frequency spectra for each vehicle

Spectra were needed for vehicles at the speeds they are assumed to be operating in the park for the modeling. For the great majority of road segments, these speeds were 40 mph for snowmobiles and 30 mph for snowcoaches. For two segments in Alternatives 2 and 4, speeds for snowmobiles are limited to 35 mph. Because the snowmobiles tended to operate at approximately 40 mph when targeting a speed of 45 mph in the pass-by tests, there is much pass-by data at the 40 mph speed. Many snowcoaches targeted and achieved 30mph.

For a given vehicle type, all the pass-by spectra at a given speed were averaged together (arithmetically), except where speeds were not within 1 or 2 mph of the desired speed (40mph for snowmobiles and 30mph for snowcoaches), and for vehicles where there was a significant difference in spectral content between the two sides of a vehicle. For vehicles where tonal peaks in the spectrum differed by more than about 5 dB in the low or mid frequencies (with a potential for controlling the audibility calculation), then pass-bys on the louder of the two sides were chosen to be included in the average for selection of BAT, because an average of the two sides would not be representative of either side. Vehicles that were computed with only one side averaged because of significant spectral differences included the Alpen Guide low exhaust Bombardier snowcoach (left side), the Polaris 500cc Wide Trak LX snowmobile (right), and the Polaris 550cc Sport Touring "control" snowmobile (right). Too few pass-bys of the 2002 Polaris stock RMK 800 were measured for an average to be computed at 40 mph.

The three 4-stroke Arctic Cat snowmobiles that were tested were all of the same model, but they exhibited differences in frequency and level of the low-frequency spectrum peaks. Averaging those spectra would not have been appropriate, so the three vehicles were separated and evaluated individually. Too few pass-bys of the first of the three 4-stroke Arctic Cat machines were run at 40 mph for an average to be computed, so only the second and third machines were evaluated in the BAT comparison. In contrast, the three 2002 4-stroke Polaris Frontier snowmobiles that were tested all had very similar spectral characteristics, particularly in the dominant 100 Hz band, so they were all grouped together and all vehicle pass-bys with speeds within 1mph of 40mph were averaged.

Figure 16 shows the average spectra for the three snowmobiles with 4-stroke engines used in the BAT evaluation. Figure 17 shows the average spectra for the three snowmobiles with 2-stroke engines that were evaluated. Figure 18 shows the average spectra for the yellow Bombardier and 2-track conversion van snowcoaches, and Figure 19 shows the average spectra for the Alpen Guide and two Mattracks snowcoaches used in the BAT evaluation.

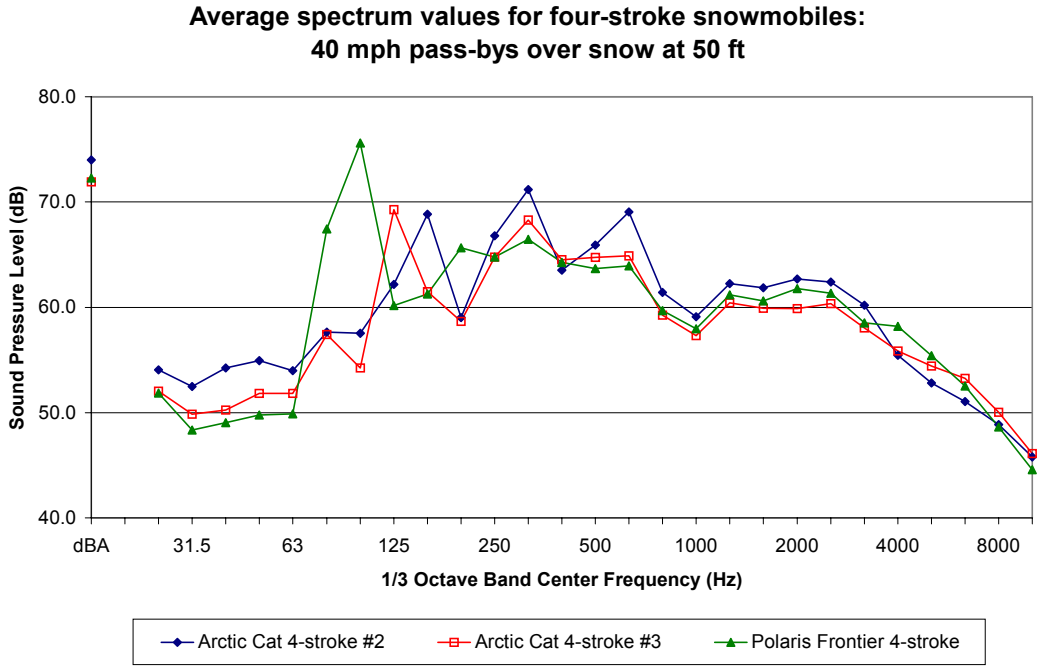

Figure 16. Average pass-by spectra for snowmobiles with 4-stroke engines

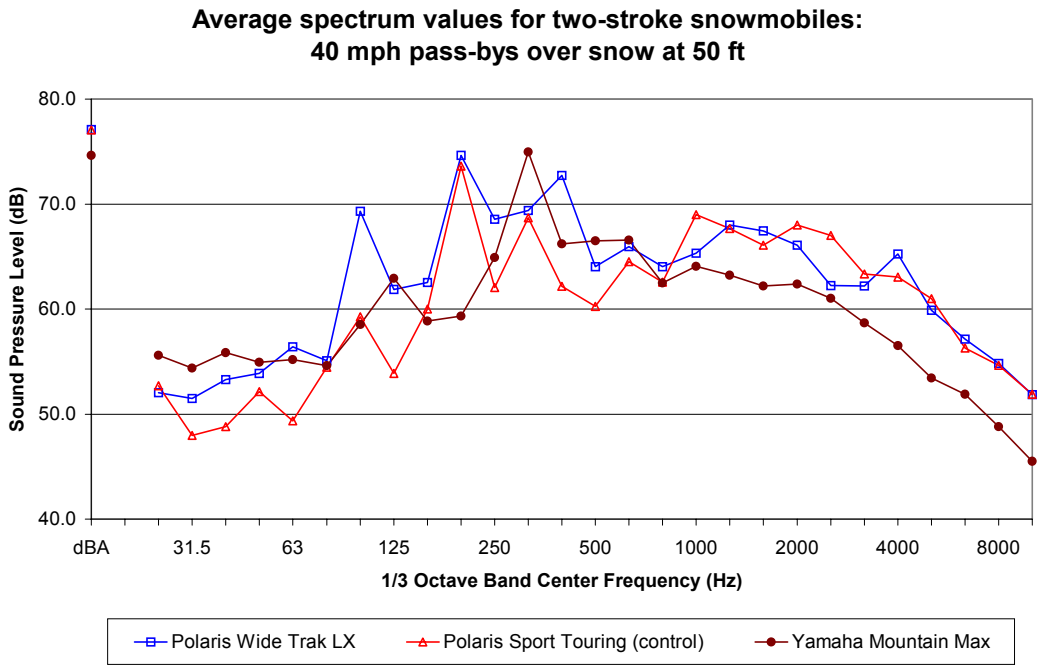

Figure 17. Average pass-by spectra for snowmobiles with 2-stoke engines

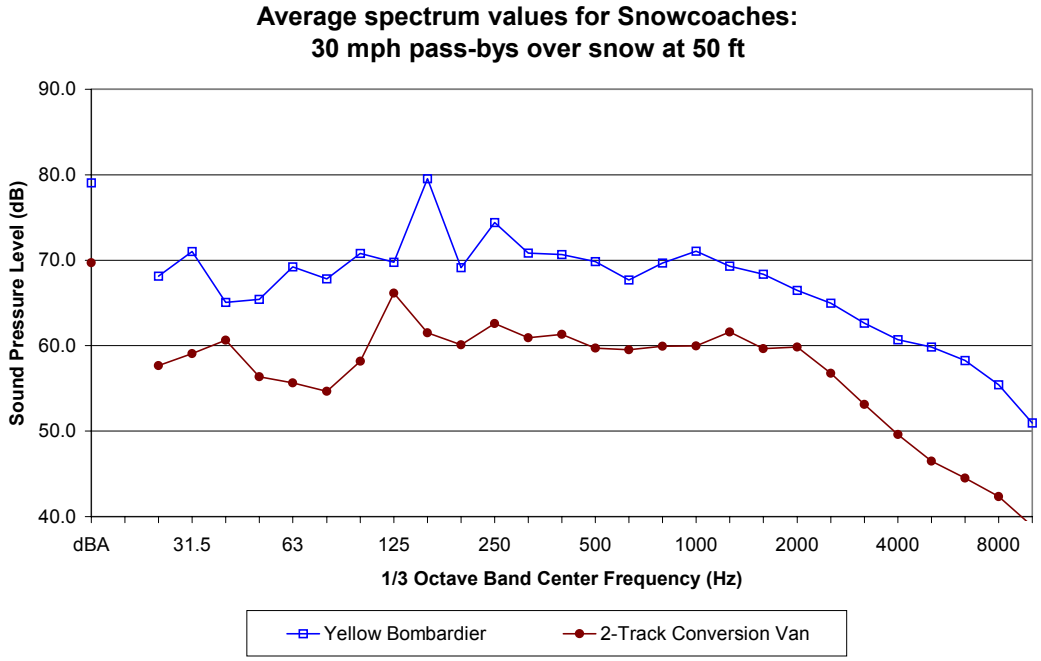

Figure 18. Average pass-by spectra for yellow Bombardier and 2-track conversion van snowcoaches

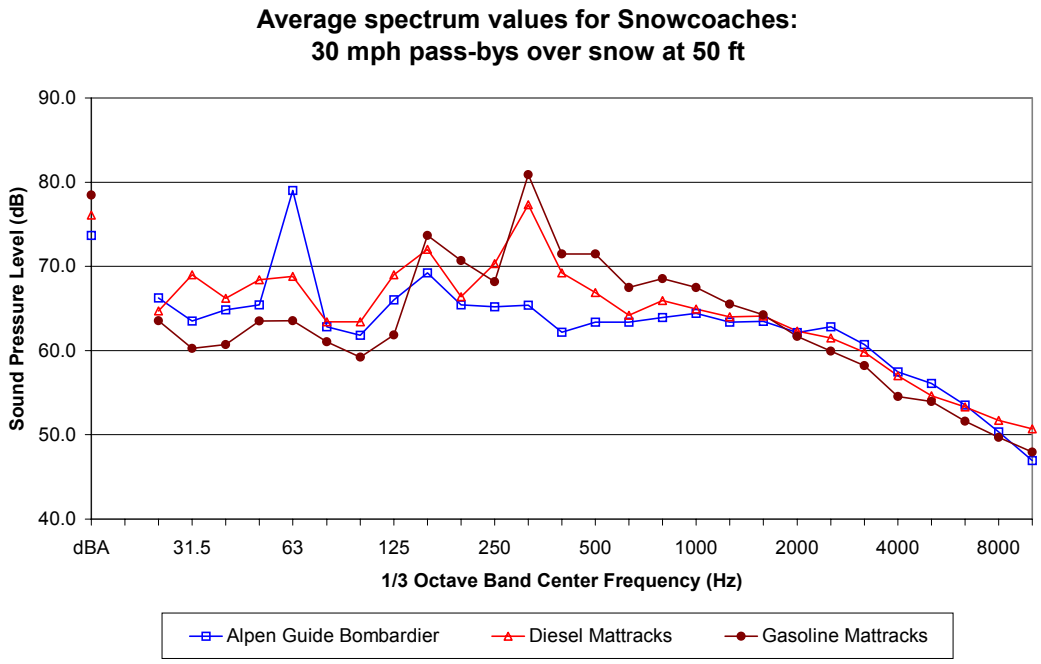

Figure 19. Average pass-by spectra for Alpen Guide Bombardier and Mattracks snowcoaches

3.2 Modeling of distance to audibility for individual vehicles

This section describes the modeling and results of the evaluation of the best available technology based on the computed distance to the limit of audibility for each of the vehicle spectra shown in the previous section.

As mentioned in the Introduction, a modified sound propagation model has been used in this Final SEIS analysis. One of the reasons for implementing the model modifications was to make the comparisons of distances to the limit of audibility more uniform among the widely varying spectral characteristics of vehicles under evaluation. The sound propagation model used in the previous noise analyses for the Winter Use Plan EIS and the Draft SEIS (based on the FHWA TNM[5]) incorporates an approximation in the calculation of ground-effect attenuation in some of the low-frequency bands that is inherent in the model. This approximation results in a discontinuity between 200 and 250 Hz. At the longer distances where the limits of audibility occur, this makes a comparison among different spectrum shapes uneven. For this BAT evaluation, the propagation model was modified to remove the approximation, such that the sound propagation for all frequencies was computed in the same manner. In addition to providing smooth variation of low-frequency attenuation with frequency, this change results in increased attenuation of sound in the frequencies below 250 Hz at longer distances. Figure 20 shows the excess attenuation due to ground-effect and atmospheric absorption as a function of frequency for the modified model at several distances. Note that attenuation due to

[5] Menge, C. W., C. F. Rossano, G. S. Anderson, and C. J. Bajdek, "FHWA Traffic Noise Model (FHWA-TNM), Version 1.0, Technical Manual" Report No. DOT-VNTSC-FHWA-98-2, February 1998.

distance is not included in these graphs. Distance attenuation contributes additional losses of 6 dB per distance doubling from the reference distance of 50 ft. This graph can be compared to the losses computed by the unmodified TNM propagation algorithms shown in Figure 28 in the June 2001 Winter Use Plan FEIS Technical Report on Noise (footnote 1).

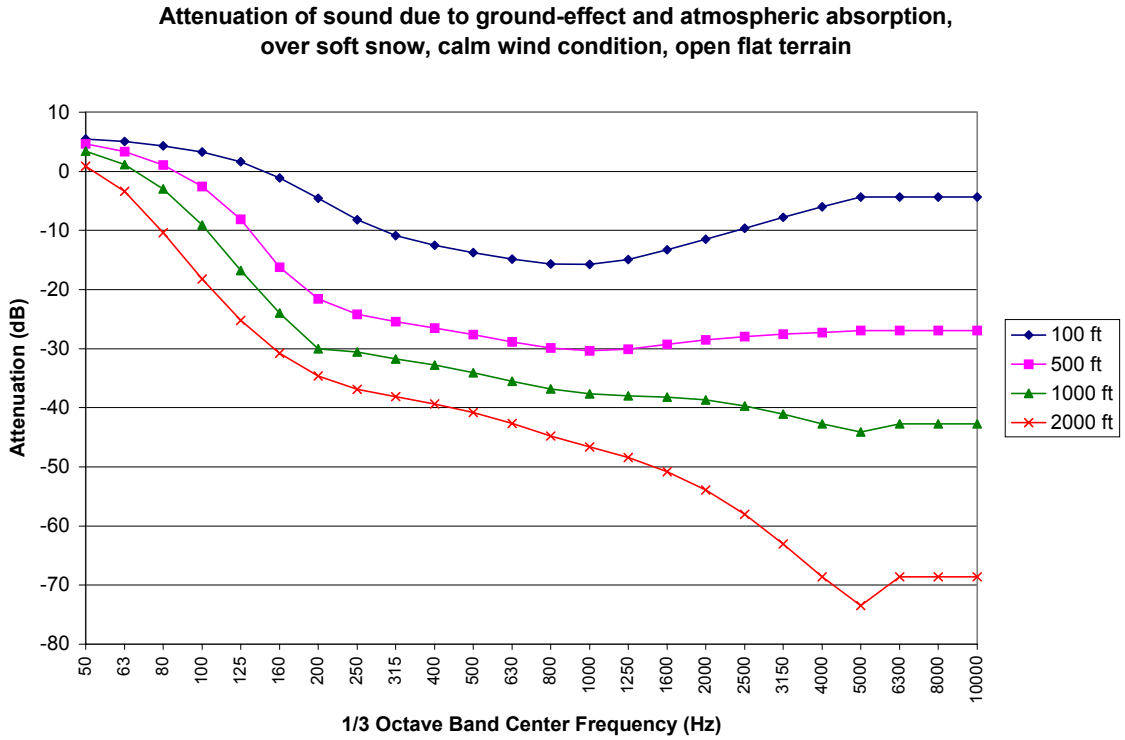

Figure 20. Excess attenuation from modified sound propagation model

The modified TNM propagation model was then used to compute distances to the limits of audibility for a single pass-by of each vehicle shown in the previous section. This computation was done in the same manner as described in Section 4.1 of the FEIS Technical Report on Noise, and below in Section 5.1. For this BAT evaluation, the comparisons were made for the open terrain and average background conditions (the rank ordering is the same for all conditions, but the distances are slightly different).

3.3 Selection of best available technology vehicles

Table 2 presents the computed distance to the limit of audibility for each of the vehicle spectra presented in Section 3.1. The vehicles with the shortest distances to the limits of audibility represent the best available technology. They are the Arctic Cat 4-stroke snowmobile #3, and the 2-track conversion van snowcoach. As a result, the average pass-by spectra shown above in Figure 16 and Figure 18 for those two vehicles were used as the reference noise emission spectra for the BAT vehicles in the modeling effort.

Table 2 also gives the average maximum A-weighted sound levels for the vehicle pass-bys.

Table 2. Distance to limits of audibility for individual vehicle pass-bys, for selection of Best Available Technology vehicles, and average maximum pass-by sound levels

Vehicle	Distance to limit of audibility [ft]	Average maximum pass-by sound level (dBA)
SNOWMOBILES		
Arctic Cat 660cc 4-Stroke #3	1011	71.9
Arctic Cat 660cc 4-Stroke #2	1167	74.0
Yamaha 600cc 3-Cylinder Mountain Max	1243	74.6
Polaris 4-Stroke Frontier (2002)	1252	72.3
Polaris 550 Sport Touring (control)	1273	77.1
Polaris 500cc Wide Trak LX	1296	77.1
SNOWCOACHES		
2-Track conversion van	904	69.7
Mattracks conversion van, diesel powered	1306	76.1
Yellow Bombardier with high exhaust	1484	79.0
Mattracks conversion van, gasoline powered	1540	78.5
Alpen Guide Bombardier with low exhaust	1575	73.7

4. MODELING ASSUMPTIONS AND INPUT

4.1 Noise emissions for additional vehicles

A representative snowmobile was also needed for modeling in Alternative 2, which calls for standard vehicles with noise emission levels no higher than 75 dBA, rather than BAT snowmobiles. The Yamaha Mountain Max represents a standard snowmobile, exhibits an emission level of 74.6 dBA and has average distance to the limit of audibility. Therefore, that vehicle was chosen as a representative snowmobile for modeling in Alternative 2.

In addition to the spectra presented in Section 3.1 for snowmobiles at 40 mph and snowcoaches at 30 mph, vehicle emission spectra were needed at 35 mph for the BAT and standard snowmobiles for modeling the segments with 35 mph speed limits in Alternatives 2 and 4. For both the Yamaha and Arctic Cat snowmobiles, measurements had been conducted at speeds in the range between 31 mph and 33 mph. The average A-weighted sound levels at these lower speeds was very close to the levels at 40 mph, so the averaged spectra for the lower speeds (32 mph average) were taken directly without adjustment. Figure 21 shows the spectra and A-levels for the vehicles modeled to represent the segments with the 35 mph speed limit. The A-levels are 72.1 dBA for the Arctic Cat and 73.6 dBA for the Yamaha.

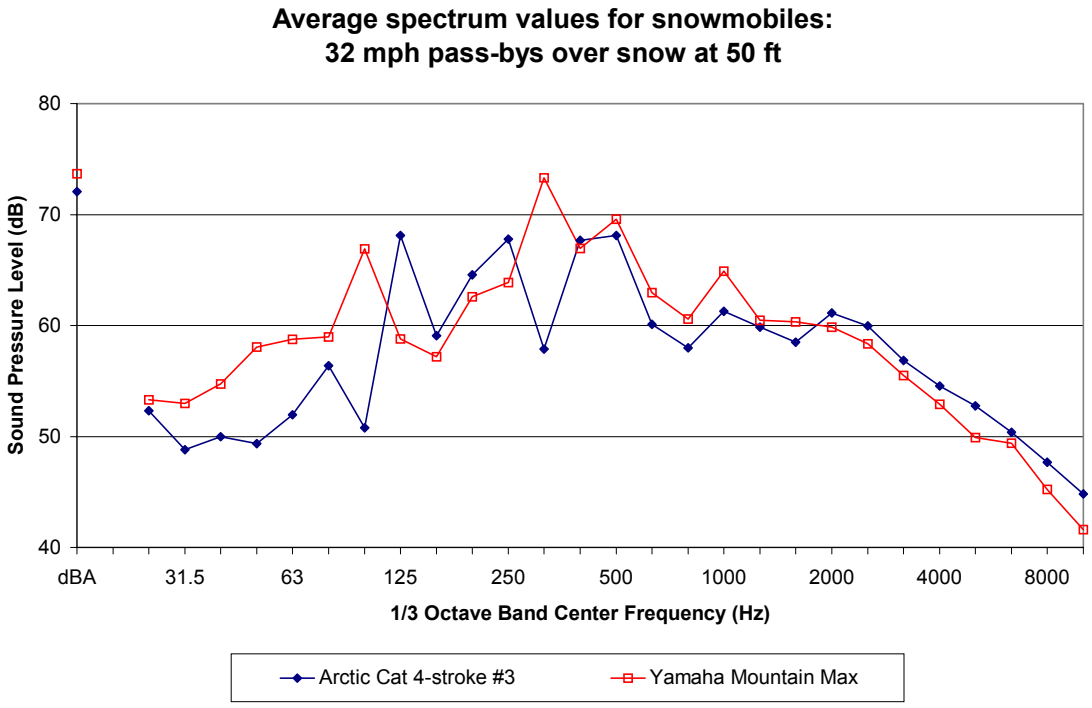

Figure 21. Snowmobile spectra to represent segments with 35 mph speed limit

4.2 Differences among alternatives

Alternative 1a: This alternative has the same vehicle volumes as Alternative G in the FEIS, that is, snowcoaches are the only permitted over-snow vehicles. However, since the over-snow vehicle noise emissions have been updated, the recently measured emission levels were used in the modeling effort. Automobile and bus emissions did not change. As in the FEIS Alternative G scenario, the mix of snowcoaches was approximately 5 to 1, BAT to the older Bombardier snowcoaches. The daily volumes on each road segment for modeled for each type of snowcoach are shown below in Table 5. The updated vehicle noise measurements resulted in a change in the BAT snowcoach from the Mattracks in the FEIS to the 2-track conversion van in this analysis. The yellow Bombardier snowcoach average spectrum shown in Figure 18 was used in the modeling.

Alternative 1b: This alternative has the same vehicle volumes as Alternative 1a. The only difference with respect to the noise analysis is the elimination of the Bombardier snowcoaches, so all snowcoaches are assumed to be the BAT 2-track conversion vans. Vehicle volumes are shown below in Table 6.

Alternative 2: This alternative includes snowmobiles as well as snowcoaches, and has also snowmobiles on Jackson Lake. All BAT snowcoaches are assumed. However, the snowmobiles are not BAT, instead standard snowmobiles are assumed, but with the pass-by noise emission level limited to 75 dBA. As described above, the Yamaha Mountain Max snowmobile measured in February 2002 was selected to represent all snowmobiles in the modeling. The average reference spectrum for this vehicle is shown in Figure 13. A 35 mph speed limit is applied to Segments 3 and 9 (between the Yellowstone west entrance and Old Faithful) in this alternative. The reference spectrum for the snowmobile at 35 mph is given in Figure 21. Vehicle volumes are shown below in Table 7.

Alternative 3: Alternative 3 has fewer snowmobiles and more snowcoaches than Alternative 2, and does not have over-snow vehicles on Jackson Lake. All vehicles are best available technology only. Vehicle volumes are shown below in Table 8.

Alternative 4: Alternative 4 has similar vehicle volumes as Alternative 2, but all vehicles are BAT only, and there are no over-snow vehicles on Jackson Lake. The 35 mph speed limit between West Yellowstone and Old Faithful is applicable in this alternative as well as in Alternative 2. Vehicle volumes are shown below in Table 9.

Table 3 presents a summary of the vehicles modeled in each of the Final SEIS alternatives.

Table 3. Over-snow vehicles modeled in each FSEIS alternative

	FSEIS Alternative/Scenario				
Vehicle	**1a**	**1b**	**2**	**3**	**4**
Snowcoach	5:1 BAT to Yellow Bombardier	BAT only	BAT only	BAT only	BAT only
Snowmobile	None	None	Average (Yamaha)	BAT (Arctic Cat 4-stroke)	BAT (Arctic Cat 4-stroke)

4.3 Vehicle volumes and roadway segment details

Table 4 provides the details on the segment lengths for each roadway, used in the computation of the number of acres of park land affected by vehicle noise. The table also lists the percentage of each road segment that was modeled as "open terrain" and as "forested terrain." Details on the soundscape characteristics of the different terrain types can be found in Section 2.4 of the FEIS Technical Report on Noise.

The average daily vehicle volumes used in the modeling are given in Table 5 through Table 9, below. In brief, Alternatives 1a and 1b exclude snowmobiles, Alternative 2 has both snowmobiles and snowcoaches (with snowmobiles on Jackson Lake), Alternative 3 is similar to Alternative 2, but has fewer snowmobiles and more snowcoaches (with no over-snow vehicles on Jackson Lake). Alternative 4 is quite similar to Alternative 2. Also, speeds are reduced to 35 mph for snowmobiles on segments 3 and 9 in Alternatives 2 and 4. Elsewhere, assumed speeds are 40 mph for snowmobiles and 30 mph for snowcoaches. Wheeled vehicle volumes, where present, are the same for each alternative.

Table 4. Roadway Segment Lengths, Percentage Open and Forested Terrain

Roadway Segment	Length [miles]	Percentage Open [%]	Percentage Forested [%]
1.Mammoth to Northeast Entrance	47	68	32
2.Mammoth to Norris	21	16	84
3.West Entrance to Madison	14	3	97
4.Madison to Norris	14	5	95
5.Norris to Canyon Village	12	0	100
6.Canyon Village to Fishing Bridge	16	29	71
7.Fishing Bridge to East Entrance	27	17	83
8.Fishing Bridge to West Thumb	21	50	50
9.Madison to Old Faithful	16	6	94
10. Old Faithful to West Thumb	17	0	100
11. West Thumb to Flagg Ranch	24	11	89
12. Grassy Lake Road	7.6	19	81
13. Flagg Ranch to Colter Bay	15.6	40	60
14. Colter Bay to Moran Junction	10.2	25	75
15. Moran Junction to East Entrance	2	50	50
16. Moran Junction to South Entrance	26	98	2
17. Jackson Lake Area	9.7	100	0
18. Teton Park Road	15	65	35
19. Moose-Wilson Road	2.5	63	37

Table 5. Average daily vehicle use for Alternative 1a

ALTERNATIVE 1A	DAILY VEHICLE USE JANUARY-FEBRUARY					
ROAD SEGMENT	Autos	Vans	Bombardier Snowcoach	BAT Snowcoach	Snowmobiles	Buses
1. Mammoth to Northeast Entrance	60	4	0	0	0	0
2. Mammoth to Norris	0	0	1	7	0	0
3. West Entrance to Madison	0	0	14	74	0	0
4. Madison to Norris	0	0	6	34	0	0
5. Norris to Canyon Village	0	0	5	25	0	0
6. Canyon Village to Fishing Bridge	0	0	4	20	0	0
7. Fishing Bridge to East Entrance	0	0	1	4	0	0
8. Fishing Bridge to West Thumb	0	0	3	17	0	0
9. Madison to Old Faithful	0	0	12	68	0	0
10. Old Faithful to West Thumb	0	0	5	29	0	0
11. West Thumb to Flagg Ranch	0	0	5	24	0	0
12. Grassy Lake Road	0	0	1	3	0	0
13. Flagg Ranch to Colter Bay	0	0	5	24	0	0
14. Colter Bay to Moran Junction	190	10	0	0	0	1
15. Moran Junction to East Entrance	560	28	0	0	0	2
16. Moran Junction to South Entrance	770	37	0	0	0	2
17. Jackson Lake Area	0	0	0	0	0	0
18. Teton Park Road	0	0	0	0	0	0
19. Moose-Wilson Road	5	0	0	0	0	0

Table 6. Average daily vehicle use for Alternative 1b

ALTERNATIVE 1B	DAILY VEHICLE USE JANUARY-FEBRUARY				
ROAD SEGMENT	Autos	Vans	BAT Snowcoach	Snowmobiles	Buses
1. Mammoth to Northeast Entrance	60	4	0	0	0
2. Mammoth to Norris	0	0	8	0	0
3. West Entrance to Madison	0	0	88	0	0
4. Madison to Norris	0	0	40	0	0
5. Norris to Canyon Village	0	0	30	0	0
6. Canyon Village to Fishing Bridge	0	0	24	0	0
7. Fishing Bridge to East Entrance	0	0	5	0	0
8. Fishing Bridge to West Thumb	0	0	20	0	0
9. Madison to Old Faithful	0	0	80	0	0
10. Old Faithful to West Thumb	0	0	34	0	0
11. West Thumb to Flagg Ranch	0	0	29	0	0
12. Grassy Lake Road	0	0	4	0	0
13. Flagg Ranch to Colter Bay	0	0	29	0	0
14. Colter Bay to Moran Junction	190	10	0	0	1
15. Moran Junction to East Entrance	560	28	0	0	2
16. Moran Junction to South Entrance	770	37	0	0	2
17. Jackson Lake Area	0	0	0	0	0
18. Teton Park Road	0	0	0	0	0
19. Moose-Wilson Road	5	0	0	0	0

Table 7. Average daily vehicle use for Alternative 2

ALTERNATIVE 2	DAILY VEHICLE USE JANUARY-FEBRUARY				
ROAD SEGMENT	Autos	Vans	BAT Snowcoach	Snowmobiles	Buses
1. Mammoth to Northeast Entrance	60	4	0	0	0
2. Mammoth to Norris	0	0	3	50	0
3. West Entrance to Madison	0	0	10	640	0
4. Madison to Norris	0	0	5	289	0
5. Norris to Canyon Village	0	0	4	214	0
6. Canyon Village to Fishing Bridge	0	0	3	173	0
7. Fishing Bridge to East Entrance	0	0	0	210	0
8. Fishing Bridge to West Thumb	0	0	2	146	0
9. Madison to Old Faithful	0	0	10	571	0
10. Old Faithful to West Thumb	0	0	4	240	0
11. West Thumb to Flagg Ranch	0	0	2	316	0
12. Grassy Lake Road	0	0	0	75	0
13. Flagg Ranch to Colter Bay	0	0	0	75	0
14. Colter Bay to Moran Junction	190	10	0	75	1
15. Moran Junction to East Entrance	560	28	0	75	2
16. Moran Junction to South Entrance	770	37	0	0	2
17. Jackson Lake Area	0	0	0	40	0
18. Teton Park Road	0	0	0	0	0
19. Moose-Wilson Road	5	0	0	0	0

Table 8. Average daily vehicle use for Alternative 3

ALTERNATIVE 3	DAILY VEHICLE USE JANUARY-FEBRUARY				
ROAD SEGMENT	Autos	Vans	BAT Snowcoach	Snowmobiles	Buses
1. Mammoth to Northeast Entrance	60	4	0	0	0
2. Mammoth to Norris	0	0	3	198	0
3. West Entrance to Madison	0	0	33	352	0
4. Madison to Norris	0	0	12	290	0
5. Norris to Canyon Village	0	0	4	215	0
6. Canyon Village to Fishing Bridge	0	0	3	174	0
7. Fishing Bridge to East Entrance	0	0	0	210	0
8. Fishing Bridge to West Thumb	0	0	3	147	0
9. Madison to Old Faithful	0	0	33	574	0
10. Old Faithful to West Thumb	0	0	5	241	0
11. West Thumb to Flagg Ranch	0	0	5	563	0
12. Grassy Lake Road	0	0	0	100	0
13. Flagg Ranch to Colter Bay	0	0	0	100	0
14. Colter Bay to Moran Junction	190	10	0	100	1
15. Moran Junction to East Entrance	560	28	0	100	2
16. Moran Junction to South Entrance	770	37	0	0	2
17. Jackson Lake Area	0	0	0	0	0
18. Teton Park Road	0	0	0	0	0
19. Moose-Wilson Road	5	0	0	0	0

Table 9. Average daily vehicle use for Alternative 4

ALTERNATIVE 4	DAILY VEHICLE USE JANUARY-FEBRUARY				
ROAD SEGMENT	Autos	Vans	BAT Snowcoach	Snowmobiles	Buses
1. Mammoth to Northeast Entrance	60	4	0	0	0
2. Mammoth to Norris	0	0	1	99	0
3. West Entrance to Madison	0	0	8	589	0
4. Madison to Norris	0	0	3	296	0
5. Norris to Canyon Village	0	0	3	219	0
6. Canyon Village to Fishing Bridge	0	0	2	178	0
7. Fishing Bridge to East Entrance	0	0	0	211	0
8. Fishing Bridge to West Thumb	0	0	2	150	0
9. Madison to Old Faithful	0	0	15	586	0
10. Old Faithful to West Thumb	0	0	4	246	0
11. West Thumb to Flagg Ranch	0	0	4	353	0
12. Grassy Lake Road	0	0	0	75	0
13. Flagg Ranch to Colter Bay	0	0	0	75	0
14. Colter Bay to Moran Junction	190	10	0	75	1
15. Moran Junction to East Entrance	560	28	0	75	2
16. Moran Junction to South Entrance	770	37	0	0	2
17. Jackson Lake Area	0	0	0	0	0
18. Teton Park Road	0	0	0	0	0
19. Moose-Wilson Road	5	0	0	0	0

4.4 Sound propagation models

As described above in Section 3.2, modifications were made to the Traffic Noise Model's ground-effect propagation algorithms for purposes of allowing a more uniform selection of best available technology vehicles. Both the original unmodified TNM and the modified propagation models have been used in this FSEIS modeling exercise to produce audibility and sound level results, which are given below in Section 5. The results for distance to audibility limits and L_{eq} produced by these two models are significantly different. Differences in the distances to the limit of audibility for single vehicle pass-bys are approximately a factor of two or three between the two models. That is, the unmodified TNM predicts distances that are approximately two to three times greater than the modified model. Differences in L_{eq} between the models are roughly 10 dB at 1000 ft, 20 dB at 4000 ft and 30 dB at 10,000 ft from a busy road segment.

The differences in results that two models produce are comparable to the differences that are observed over such distances under different atmospheric conditions. The modified TNM algorithms represent sound propagation from a sound source near the surface of the snow over flat, soft snow with no refracting effects of the atmosphere (neutral atmospheric conditions). The resulting ground-effect attenuation is very significant (see Figure 20), relative to what would be present over an acoustically harder surface, such as earth. (Refraction is the bending of sound waves due to wind or temperature gradients. Sound refracts downward when propagating downwind or with a temperature inversion (warmer with increasing height); this reduces ground-effect attenuation that is present under neutral atmospheric conditions, increasing sound levels. Sound refracts upward when propagating upwind or with a temperature lapse (cooler with increasing height); this effect reduces

sound levels relative to neutral conditions.) Therefore, a downwind or temperature inversion condition is expected to increase sound levels significantly, since there is so much ground-effect attenuation that can be lost. So, the modified propagation model is seen to represent a "best-case" condition that preserves the strong ground-effect attenuation with soft snow and calm, neutral atmospheric conditions.

As described in Section 3.2, the unmodified TNM propagation model uses less ground-effect attenuation in the low-frequency bands and therefore predicts higher sound levels and longer distances to the limits of audibility. As stated above, ground-effect attenuation is reduced with downward-refracting atmospheric conditions as well as with conditions of a harder ground surface. Therefore, the unmodified model is seen as likely to be representative of a "worst-case" condition that would be consistent with firmer snow and/or downwind or temperature inversion atmospheric conditions. Here, "worst case" refers to relatively high levels of vehicle noise, and longer distances to the limits of audibility

To the authors' knowledge, no published empirical data are available on the propagation of snowmachine noise over snow for long distances. Further, very limited data have been published on long-distance sound propagation over snow that would be directly applicable to this study. In an effort to validate the applicability of the above characterizations of the TNM-based models to the described atmospheric conditions, computations of those two models have been compared to those of a model that explicitly accounts for the atmospheric effects of wind and temperature gradients. That model was developed by the U.S. Army Construction Engineering Research Laboratory (CERL) and is called SoundProp[6]. This model is based on the calculations of a complex Fast Field Program[7] (FFP) that incorporates the refracting effects of the atmosphere. SoundProp/FFP results have been validated by CERL for sound from weapons fire traveling long distances over soft surfaces (earth) and hard surfaces (water). Since this model does not account for the acoustically softer ground surface that snow represents, its results were examined for propagation over earth, and therefore must be interpreted accordingly.

The SoundProp model was used to compute approximate distances to the limits of audibility for the pass-bys of the individual over-snow vehicles under different atmospheric conditions. SoundProp was run at many distances over "soft ground" (earth) for both "zero gradient" (neutral) atmospheric conditions and the "moderate downwind" (downward refracting) conditions. Naturally, SoundProp computes longer distances to the limits of audibility than the TNM propagation, because earth is an acoustically harder ground type than snow, which exhibits much greater ground-effect losses. However, SoundProp computes *differences* between the neutral and downwind conditions that are consistent with the observed differences between the unmodified and modified TNM-based models. That is, the SoundProp "downwind" distances to the limits of audibility are approximately two times greater than those computed with "zero gradient," for the vehicles used in the model exercise[8]. This agreement is seen as reasonable validation of the characterizations of the unmodified TNM-based model as representing "worst-case" downwind or temperature inversion conditions and/or firm snow, and the modified TNM algorithms as representing "best-case" neutral conditions over soft snow.

[6] Michael J. White, "Estimating attenuation and propagation of noise bands from a distant source using the Lookup program and database," US Army Corps of Engineers Construction Engineering Research Laboratories, USACERL Technical Report EC-94/12, September 1994.
[7] Y. L. Li, Michael J. White, S. J. Franke, "New fast field programs for anisotropic sound propagation though an atmosphere with a wind velocity profile," *J. Acoust. Soc. Am.* **95** (2), February 1994.
[8] As a matter of information, the distances to audibility limits computed by SoundProp over earth are approximately two to three times greater than the comparable distances over snow computed by the TNM-based models.

5. MODELING RESULTS

5.1 Audibility of Single Events

Table 10 presents the computed distances to the limits of audibility of a single pass-by of each vehicle type over snow in the Open (or lightly forested) and Forested (moderately to heavily) terrain for both the Average and Quiet background conditions[9]. This table was prepared for the worst-case sound propagation conditions, characteristic of downwind or temperature inversion atmospheric conditions and/or firm snow. Table 11 presents the same information computed with the best-case propagation conditions, representative of calm winds, neutral atmospherics and soft snow. Distances are shown for different sized groups of snowmobiles, since such groups are common. The computations can be interpreted as follows: *beyond* the distance shown, the vehicle would not be audible; *at* the distance shown, the vehicle would be barely audible for only a few seconds; *closer than* the distance shown, the vehicle would be more clearly audible and for longer.

Since the distances to audibility limits are based on the unique frequency characteristics of the sound sources, the background environments and the human auditory system, comparisons of the A-weighted sound levels alone will not lead to an understanding of differences. Differences in the distances between the average and quiet background conditions are relatively small since the difference in the background sound levels are relatively small. The difference in distances between open terrain and forested terrain is generally larger because vehicle sound levels drop off more quickly with distance in the forested environment. Differences in distances between worst-case and best-case propagation conditions are significant due to the significant effect of atmospheric and snow conditions on sound propagation (further discussion of sound propagation is given in the previous section). The distances computed with the best-case propagation conditions present the most uniform comparison among the vehicle types.

Table 10. Worst case distances to limits of audibility for individual vehicle pass-bys over snow in open and forested terrain and in average and quiet background conditions.

Worst Case Condition / Vehicle Type	Maximum 50 ft Pass-by Level (dBA)	Distance to Limit of Audibility (feet)			
		Open Terrain		Forested Terrain	
		Average Backgrnd	Quiet Backgrnd	Average Backgrnd	Quiet Backgrnd
Automobile	68.0	2,180	2,330	1,130	1,200
Bus	76.0	5,520	6,090	2,620	2,860
Bombardier Snowcoach	79.0	11,830	13,420	5,200	5,720
(BAT) 2-Track Conversion Van Snowcoach	69.7	2,630	2,800	1,360	1,440
Mountain Max Snowmobile	74.6	2,110	2,270	1,160	1,260
(BAT) Artic Cat Snowmobile	71.9	3,250	3,410	1,610	1,670
(BAT) Group of 2 Snowmobiles	71.9 each	4,320	4,540	2,060	2,140
(BAT) Group of 4 Snowmobiles	71.9 each	5,810	6,120	2,660	2,770
(BAT) Group of 8 Snowmobiles	71.9 each	7,920	8,340	3,480	3,630
(BAT) Group of 12 Snowmobiles	71.9 each	9,550	10,070	4,100	4,280

[9] The background conditions described in the FEIS are based on measured L_{90} values and are as follows: Average background levels are 20 dBA and 22 dBA for the Open and Forested terrain, respectively; Quiet background levels are 15 dBA and 18 dBA for the Open and Forested terrain, respectively. See Section 2.4 of the FEIS Noise Technical report for more details on measurements of the background soundscape.

Table 11. Best case distances to limits of audibility for individual vehicle pass-bys over snow in open and forested terrain and in average and quiet background conditions.

Best Case Condition / Vehicle Type	Maximum 50 ft Pass-by Level (dBA)	Distance to Limit of Audibility (feet)			
		Open Terrain		Forested Terrain	
		Average Backgrnd	Quiet Backgrnd	Average Backgrnd	Quiet Backgrnd
Automobile	68.0	850	860	680	680
Bus	76.0	1,160	1,170	910	910
Bombardier Snowcoach	79.0	1,480	1,660	960	1,000
(BAT) 2-Track Conversion Van Snowcoach	69.7	900	1,000	580	600
Mountain Max Snowmobile	74.6	1,180	1,390	740	850
(BAT) Arctic Cat Snowmobile	71.9	1,010	1,180	650	700
(BAT) Group of 2 Snowmobiles	71.9 each	1,180	1,390	750	810
(BAT) Group of 4 Snowmobiles	71.9 each	1,380	1,630	860	940
(BAT) Group of 8 Snowmobiles	71.9 each	1,620	1,920	1,000	1,090
(BAT) Group of 12 Snowmobiles	71.9 each	1,780	2,110	1,090	1,200

5.2 Distances to Audibility Metrics: Cumulative Effects of All Vehicles

The contributions from all vehicles during the day (defined as 8 a.m. to 6 p.m.) were accounted for, and distances to three metrics of audibility were computed, according to the approach described in Section 3 of the FEIS noise technical report. The three different audibility conditions are: 1) distance to the limit of audibility for all vehicles during the day, 2) distance to where vehicles would be audible 10% of the time or more, and 3) distance to where vehicles would be audible 50% of the time or more, if vehicles would be audible that long. Choosing these latter two metrics in addition to the distance to the limit of audibility metric allows the following questions to be answered: "How far do you have to go away from a road so that you won't hear snow-machine noise for more than 10% of the time throughout the day?" and "…for more than half the time?"

Table 12 through Table 16 show the distances to the limits of audibility for each project alternative for the worst-case propagation conditions of downwind or temperature inversion atmospherics and/or firm snow. These tables present the distances from each road segment within which over-snow or wheeled vehicle sound would be audible under the two background conditions, average and quiet, and in the two terrain types. Where blanks exist in the table, the vehicles on that segment would not meet that condition. Table 17 through Table 21 present the distances to audibility for each project alternative for the best-case propagation conditions of soft snow and calm winds and neutral atmospheric conditions.

It should be noted that there are no over-snow vehicles on road segments 1 and 14 through 19 in Alternatives 1a and 1b, and no over-snow vehicles in segments 1, 16, 18 and 19 in Alternative 2. In Alternatives 3 and 4, there are no over-snow vehicles on segments 1 and 16 through 19. In those cases, the projected audibility is entirely due to autos, vans, and buses on plowed roads, the volumes of which do not change across any of the alternatives.

Table 12. Distances to vehicle audibility, Alternative 1a, worst case conditions

Alternative 1a	Distance to audibility of vehicles (ft)											
Worst case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	3,276	1,406		1,884			3,398	1,637		2,007		
2. Mammoth to Norris	12,524			5,115			14,065			5,764		
3. West Entrance to Madison	17,728	11,506		7,167	2,373		20,753	13,448		7,827	2,837	
4. Madison to Norris	12,605	3,657		5,162	296		14,144	5,173		5,809	647	
5. Norris to Canyon Village	12,583	2,851		5,127			14,128	3,416		5,778		
6. Canyon Village to Fishing Bridge	12,524	2,010		5,115			14,065	2,422		5,764		
7. Fishing Bridge to East Entrance	12,482			5,109			14,019			5,756		
8. Fishing Bridge to West Thumb	12,524			5,115			14,065	832		5,764		
9. Madison to Old Faithful	17,349	10,398		7,167	2,125		19,951	12,553		7,827	2,517	
10. Old Faithful to West Thumb	12,583	3,052		5,127			14,128	3,531		5,778		
11. West Thumb to Flagg Ranch	12,583	2,796		5,127			14,128	3,399		5,778		
12. Grassy Lake Road	12,471			5,108			14,006			5,755		
13. Flagg Ranch to Colter Bay	12,583	2,796		5,127			14,128	3,399		5,778		
14. Colter Bay to Moran Junction	5,642	2,949		3,058	985		6,281	3,121		3,219	1,159	
15. Moran Junction to East Entrance	6,648	3,889	3,130	3,194	1,946	779	7,317	4,264	3,346	3,356	2,120	919
16. Moran Junction to South Entrance	6,965	4,627	3,576	3,232	2,145	1,026	7,650	5,385	3,798	3,393	2,317	1,255
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	2,669			1,336			2,785			1,454		

Table 13. Distances to vehicle audibility, Alternative 1b, worst case conditions

Alternative 1b	Distance to audibility of vehicles (ft)											
Worst case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	3,276	1,406		1,884			3,398	1,637		2,007		
2. Mammoth to Norris	3,125			1,764			3,240			1,888		
3. West Entrance to Madison	4,258	3,133		2,557	1,345		4,728	3,284		2,695	1,510	
4. Madison to Norris	3,603	1,839		2,264			3,716	2,081		2,386		
5. Norris to Canyon Village	3,245			1,810			3,366	365		1,941		
6. Canyon Village to Fishing Bridge	3,125			1,764			3,240			1,888		
7. Fishing Bridge to East Entrance	3,083			1,748			3,195			1,870		
8. Fishing Bridge to West Thumb	3,125			1,764			3,240			1,888		
9. Madison to Old Faithful	4,258	2,880		2,557	673		4,728	3,059		2,695	928	
10. Old Faithful to West Thumb	3,603			2,264			3,716	540		2,386		
11. West Thumb to Flagg Ranch	3,245			1,810			3,366	337		1,941		
12. Grassy Lake Road	3,077			1,746			3,189			1,867		
13. Flagg Ranch to Colter Bay	3,245			1,810			3,366	337		1,941		
14. Colter Bay to Moran Junction	5,642	2,949		3,058	985		6,281	3,121		3,219	1,159	
15. Moran Junction to East Entrance	6,648	3,889	3,130	3,194	1,946	779	7,317	4,264	3,346	3,356	2,120	919
16. Moran Junction to South Entrance	6,965	4,627	3,576	3,232	2,145	1,026	7,650	5,385	3,798	3,393	2,317	1,255
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	2,669			1,336			2,785			1,454		

Table 14. Distances to vehicle audibility, Alternative 2, worst case conditions

Alternative 2	Distance to audibility of vehicles (ft)											
Worst case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	3,276	1,406		1,884			3,398	1,637		2,007		
2. Mammoth to Norris	3,252	1,352		1,817			3,378	1,589		1,961		
3. West Entrance to Madison	6,785	5,217	3,867	3,125	2,452	1,510	7,270	5,828	4,175	3,351	2,722	1,858
4. Madison to Norris	3,733	3,273		2,222	1,498		3,869	3,439	1,006	2,405	1,717	
5. Norris to Canyon Village	3,708	3,073		2,185	1,395		3,845	3,226		2,370	1,598	
6. Canyon Village to Fishing Bridge	3,573	2,775		2,058	836		3,712	2,959		2,243	1,033	
7. Fishing Bridge to East Entrance	3,708	2,935		2,185	1,049		3,845	3,109		2,370	1,277	
8. Fishing Bridge to West Thumb	3,573	2,666		2,057	789		3,712	2,847		2,242	973	
9. Madison to Old Faithful	6,771	5,032	3,788	3,128	2,400	1,467	7,251	5,653	3,961	3,355	2,665	1,812
10. Old Faithful to West Thumb	3,709	3,146		2,185	1,459		3,846	3,306		2,370	1,668	
11. West Thumb to Flagg Ranch	3,849	3,290	1,541	2,274	1,504		3,990	3,456	1,858	2,465	1,726	
12. Grassy Lake Road	3,357	1,555		1,779			3,503	1,779		1,972		
13. Flagg Ranch to Colter Bay	3,357	1,555		1,779			3,503	1,779		1,972		
14. Colter Bay to Moran Junction	5,657	3,250		3,059	1,470		6,299	3,409		3,220	1,633	
15. Moran Junction to East Entrance	6,732	3,986	3,268	3,195	2,026	826	7,417	4,710	3,493	3,357	2,210	975
16. Moran Junction to South Entrance	6,965	4,627	3,576	3,232	2,145	1,026	7,650	5,385	3,798	3,393	0	0
17. Jackson Lake Area	3,185			1,714			3,323			1,894		
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	2,669			1,336			2,785			1,454		

Table 15. Distances to vehicle audibility, Alternative 3, worst case conditions

Alternative 3	Distance to audibility of vehicles (ft)											
Worst case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	3,276	1,406		1,884			3,398	1,637		2,007		
2. Mammoth to Norris	7,105	4,385	284	3,076	2,112		7,555	4,891	1,351	3,166	2,230	
3. West Entrance to Madison	8,792	6,534	4,131	3,320	2,639	315	9,610	7,069	4,759	3,419	2,750	583
4. Madison to Norris	7,422	5,770	3,389	3,129	2,530		7,881	6,299	3,662	3,221	2,635	
5. Norris to Canyon Village	7,105	4,489	1,989	3,076	2,266		7,555	5,005	2,376	3,166	2,370	
6. Canyon Village to Fishing Bridge	6,452	3,993		2,944	1,948		6,903	4,490		3,033	2,066	
7. Fishing Bridge to East Entrance	7,105	4,472	1,415	3,076	2,164		7,555	4,981	1,873	3,166	2,276	
8. Fishing Bridge to West Thumb	6,452	3,847		2,944	1,864		6,903	3,967		3,033	1,978	
9. Madison to Old Faithful	10,891	8,338	6,760	3,660	2,999	2,152	11,708	9,293	7,380	3,756	3,110	2,300
10. Old Faithful to West Thumb	7,117	4,928	2,521	3,077	2,437		7,569	5,452	2,882	3,167	2,530	
11. West Thumb to Flagg Ranch	10,785	8,043	6,507	3,633	2,951	2,110	11,611	8,985	7,109	3,726	3,061	2,253
12. Grassy Lake Road	5,507	3,559		2,704	1,748		5,943	3,668		2,798	1,852	
13. Flagg Ranch to Colter Bay	5,507	3,559		2,704	1,748		5,943	3,668		2,798	1,852	
14. Colter Bay to Moran Junction	6,173	3,848	1,493	3,084	1,897		6,725	3,986	1,874	3,244	2,025	
15. Moran Junction to East Entrance	7,207	5,256	3,594	3,225	2,306	892	7,777	5,946	3,817	3,383	2,464	1,060
16. Moran Junction to South Entrance	6,965	4,627	3,576	3,232	2,145	1,026	7,650	5,385	3,798	3,393	2,317	1,255
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	2,669			1,336			2,785			1,454		

Table 16. Distances to vehicle audibility, Alternative 4, worst case conditions

Alternative 4	Distance to audibility of vehicles (ft)											
Worst case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	3,276	1,406		1,884			3,398	1,637		2,007		
2. Mammoth to Norris	5,497	3,534		2,704	1,745		5,931	3,643		2,797	1,848	
3. West Entrance to Madison	10,187	8,765	6,950	3,649	3,110	2,355	11,141	9,812	7,618	3,831	3,328	2,634
4. Madison to Norris	7,404	5,716	3,331	3,110	2,526		7,878	6,239	3,613	3,199	2,631	
5. Norris to Canyon Village	7,117	4,581	2,060	3,077	2,383		7,569	5,093	2,446	3,167	2,474	
6. Canyon Village to Fishing Bridge	7,105	4,022		3,037	1,964		7,555	4,539		3,131	2,081	
7. Fishing Bridge to East Entrance	7,105	4,474	1,541	3,076	2,189		7,555	4,984	1,985	3,166	2,299	
8. Fishing Bridge to West Thumb	6,452	3,870		2,944	1,871		6,903	3,991		3,033	1,986	
9. Madison to Old Faithful	10,465	8,772	6,960	3,695	3,115	2,361	11,374	9,819	7,617	3,879	3,332	2,641
10. Old Faithful to West Thumb	7,117	5,030	2,564	3,077	2,447		7,569	5,550	2,929	3,167	2,543	
11. West Thumb to Flagg Ranch	8,671	6,317	3,907	3,316	2,604	129	9,468	6,847	4,367	3,414	2,712	376
12. Grassy Lake Road	5,475	3,107		2,702	181		5,906	3,263		2,795	430	
13. Flagg Ranch to Colter Bay	5,475	3,107		2,702	181		5,906	3,263		2,795	430	
14. Colter Bay to Moran Junction	6,072	3,714		3,061	1,805		6,646	3,847	295	3,221	1,927	
15. Moran Junction to East Entrance	7,091	4,808	3,475	3,225	2,234	853	7,767	5,496	3,700	3,383	2,385	997
16. Moran Junction to South Entrance	6,965	4,627	3,576	3,232	2,145	1,026	7,650	5,385	3,798	3,393	2,317	1,255
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	2,669			1,336			2,785			1,454		

Table 17. Distances to vehicle audibility, Alternative 1a, best case conditions

Alternative 1a	Distance to audibility of vehicles (ft)											
Best case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	1,122			926			1,127			927		
2. Mammoth to Norris	1,894			978			2,106			995		
3. West Entrance to Madison	2,021	480		986			2,256	696		1,023		
4. Madison to Norris	1,916			980			2,133			998		
5. Norris to Canyon Village	1,894			978			2,106			995		
6. Canyon Village to Fishing Bridge	1,894		0	978		0	2,106		0	995		0
7. Fishing Bridge to East Entrance	1,894			978			2,106			995		
8. Fishing Bridge to West Thumb	1,894			978			2,106			995		
9. Madison to Old Faithful	2,014			986			2,253			1,023		
10. Old Faithful to West Thumb	1,894			978			2,106			995		
11. West Thumb to Flagg Ranch	1,894			978			2,106			995		
12. Grassy Lake Road	1,894			978			2,106			995		
13. Flagg Ranch to Colter Bay	1,894			978			2,106			995		
14. Colter Bay to Moran Junction	1,379	146		974			1,395	152		975		
15. Moran Junction to East Entrance	1,474	982	112	984	882		1,489	983	118	984	883	
16. Moran Junction to South Entrance	1,504	987	146	995	887		1,517	988	152	996	888	
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	955			857			956			859		

Table 18. Distances to vehicle audibility, Alternative 1b, best case conditions

Alternative 1b	Distance to audibility of vehicles (ft)											
Best case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	1,122			926			1,127			927		
2. Mammoth to Norris	989			801			1,101			817		
3. West Entrance to Madison	1,263			852			1,450			868		
4. Madison to Norris	1,243			852			1,414		0	868		
5. Norris to Canyon Village	989			801			1,103			817		
6. Canyon Village to Fishing Bridge	989			801			1,101			817		
7. Fishing Bridge to East Entrance	989			801			1,101			817		
8. Fishing Bridge to West Thumb	989			801			1,101			817		
9. Madison to Old Faithful	1,263			852			1,450			868		
10. Old Faithful to West Thumb	1,243			852			1,414			868		
11. West Thumb to Flagg Ranch	989			801			1,103		0	817		
12. Grassy Lake Road	989	0		801	0		1,101	0		817	0	
13. Flagg Ranch to Colter Bay	989			801			1,103		0	817		
14. Colter Bay to Moran Junction	1,379	146		974			1,395	152		975		
15. Moran Junction to East Entrance	1,474	982	112	984	882		1,489	983	118	984	883	
16. Moran Junction to South Entrance	1,504	987	146	995	887		1,517	988	152	996	888	
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	955			857			956			859		

Table 19. Distances to vehicle audibility, Alternative 2, best case conditions

Alternative 2	Distance to audibility of vehicles (ft)											
Best case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	1,122			926			1,127			927		
2. Mammoth to Norris	1,210			905			1,941			959		
3. West Entrance to Madison	2,118	1,545	903	983	892		2,564	2,011	1,378	1,213	939	144
4. Madison to Norris	1,509	1,095		951	887		2,250	1,824		1,044	939	
5. Norris to Canyon Village	1,487	788		950			2,206	1,363		1,031	289	
6. Canyon Village to Fishing Bridge	1,436	466		942			2,150	1,205		995		
7. Fishing Bridge to East Entrance	1,487	505		950			2,206	1,308		1,031		
8. Fishing Bridge to West Thumb	1,436	459		942			2,150	1,194		995		
9. Madison to Old Faithful	2,119	1,495	902	983	885		2,565	1,966	1,372	1,213	932	144
10. Old Faithful to West Thumb	1,487	796		950			2,206	1,582		1,031	331	
11. West Thumb to Flagg Ranch	1,509	1,096		951	887		2,250	1,833		1,044	939	
12. Grassy Lake Road	1,591			905			1,956			959		
13. Flagg Ranch to Colter Bay	1,591			905			1,956			959		
14. Colter Bay to Moran Junction	1,611	959		975	853		1,964	984		977	859	
15. Moran Junction to East Entrance	1,615	987	113	984	882		1,966	1,187	120	985	887	
16. Moran Junction to South Entrance	1,504	987	146	995	887		1,517	988	152	996	888	
17. Jackson Lake Area	1,580			905			1,939			959		
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	955			857			956			859		

Table 20. Distances to vehicle audibility, Alternative 3, best case conditions

Alternative 3	Distance to audibility of vehicles (ft)											
Best case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	1,122			926			1,127			927		
2. Mammoth to Norris	1,487	497		901			1,839	879		932		
3. West Entrance to Madison	1,526	1,098		902	841		1,904	1,465		934	870	
4. Madison to Norris	1,510	1,095		902	841		1,876	1,451		934	870	
5. Norris to Canyon Village	1,487	788		901			1,839	1,125		932		
6. Canyon Village to Fishing Bridge	1,436	466		894			1,787	826		924		
7. Fishing Bridge to East Entrance	1,487	505		901			1,839	893		932		
8. Fishing Bridge to West Thumb	1,436	459		894			1,786	813		924		
9. Madison to Old Faithful	1,752	1,153	460	935	856		2,134	1,541	813	968	877	
10. Old Faithful to West Thumb	1,487	828		901			1,839	1,187		932		
11. West Thumb to Flagg Ranch	1,750	1,129	459	935	846		2,132	1,517	812	968	876	
12. Grassy Lake Road	1,213	459		856			1,580	811		887		
13. Flagg Ranch to Colter Bay	1,213	459		856			1,580	811		887		
14. Colter Bay to Moran Junction	1,383	955		974	824		1,606	962		975	844	
15. Moran Junction to East Entrance	1,475	988	114	984	882		1,621	1,014	120	985	883	
16. Moran Junction to South Entrance	1,504	987	146	995	887		1,517	988	152	996	888	
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	955			857			956			859		

Table 21. Distances to vehicle audibility, Alternative 4, best case conditions

Alternative 4	Distance to audibility of vehicles (ft)											
Best case conditions	Average Background Open Terrain			Average Background Forested Terrain			Quiet Background Open Terrain			Quiet Background Forested Terrain		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	1,122			926			1,127			927		
2. Mammoth to Norris	1,213	459		856			1,580	811		887		
3. West Entrance to Madison	1,852	1,241	699	932	845		2,343	1,753	1,125	975	881	
4. Madison to Norris	1,509	1,095		902	841		1,874	1,451		934	870	
5. Norris to Canyon Village	1,487	788		901			1,839	1,176		932		
6. Canyon Village to Fishing Bridge	1,443	467		894			1,798	827		924		
7. Fishing Bridge to East Entrance	1,487	508		901			1,839	900		932		
8. Fishing Bridge to West Thumb	1,436	459		894			1,786	813		924		
9. Madison to Old Faithful	1,858	1,242	699	932	846		2,352	1,754	1,124	975	881	
10. Old Faithful to West Thumb	1,487	838		901			1,839	1,189		932		
11. West Thumb to Flagg Ranch	1,526	1,098		902	841		1,904	1,463		934	870	
12. Grassy Lake Road	1,213			856			1,580			887		
13. Flagg Ranch to Colter Bay	1,213			856			1,580			887		
14. Colter Bay to Moran Junction	1,383	955		974	824		1,606	961		975	837	
15. Moran Junction to East Entrance	1,474	986	113	984	882		1,611	988	120	985	883	
16. Moran Junction to South Entrance	1,504	987	146	995	887		1,517	988	152	996	888	
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	955			857			956			859		

5.3 Acres of Affected Park Land

The previous section contains tables with distances to audibility metrics for each segment and each alternative. The following section presents the area of park land in acres where any vehicle noise would be audible under the two background conditions, average and quiet. Results are shown separately for the worst-case and best-case sound propagation conditions. Worst-case propagation conditions represent downwind or temperature inversion atmospherics and/or firm snow. Best-case propagation conditions represent soft snow and calm winds with neutral atmospheric conditions. (See Section 4.4 for a detailed discussion of the differences in sound propagation.) The areas shown in this section are computed by multiplying the distances to audibility presented in the previous section by each roadway segment length. Segment lengths and their percentages of open and forested terrain were given in Table 4. For each background condition, acreage is presented for three categories of vehicle audibility: (1) audible for any amount of time (labeled "Audible at all"), (2) audible for 10% of the time or more, and (3) audible for 50% of the time or more.

5.3.1 Summary results

Table 22 presents a summary of the total acres of affected park land for each project alternative.

As explained in more detail below, some of the acreage in Table 22 is due to wheeled vehicles on plowed roads, the volumes of which do not change in any of the SEIS alternatives.

Table 22. Total Acres of affected park land where vehicles are audible

Alternative	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
Worst case conditions						
1a	219,960	36,907	11,582	243,881	44,898	12,327
1b	107,561	26,495	11,582	114,432	31,173	12,327
2	119,975	58,497	17,894	128,495	66,522	19,987
3	147,834	91,417	26,287	155,488	98,680	29,246
4	145,874	86,751	23,702	153,864	94,390	26,676
Best case conditions						
1a	44,128	3,401	464	45,538	3,417	485
1b	36,971	3,377	464	37,868	3,382	485
2	44,194	13,051	615	49,644	16,749	1,215
3	40,549	13,283	664	42,896	15,091	839
4	40,260	12,827	581	42,664	14,336	673

5.3.2 Detailed results by roadway segment

Table 23 through Table 32 below provide details on the affected acreage for each roadway segment and project alternative, showing where this acreage occurs.

Table 23. Acres of affected park land where vehicles would be audible by road segment, Alternative 1a, worst case conditions

Alternative 1a Worst case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	16,126	5,445	0	16,822	6,342	0
2. Mammoth to Norris	16,038	0	0	18,054	0	0
3. West Entrance to Madison	12,700	4,493	0	13,940	5,355	0
4. Madison to Norris	9,391	788	0	10,565	1,482	0
5. Norris to Canyon Village	7,458	0	0	8,405	0	0
6. Canyon Village to Fishing Bridge	14,087	1,130	0	15,848	1,362	0
7. Fishing Bridge to East Entrance	20,822	0	0	23,436	0	0
8. Fishing Bridge to West Thumb	22,450	0	0	25,238	1,058	0
9. Madison to Old Faithful	15,084	5,084	0	16,590	6,049	0
10. Old Faithful to West Thumb	10,565	0	0	11,907	0	0
11. West Thumb to Flagg Ranch	17,301	895	0	19,481	1,088	0
12. Grassy Lake Road	5,994	0	0	6,746	0	0
13. Flagg Ranch to Colter Bay	15,334	2,115	0	17,241	2,571	0
14. Colter Bay to Moran Junction	4,579	1,825	0	4,926	2,040	0
15. Moran Junction to East Entrance	1,193	707	474	1,294	774	517
16. Moran Junction to South Entrance	21,714	14,425	11,108	23,842	16,777	11,810
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	9,124	0	0	9,548	0	0
Total	219,960	36,907	11,582	243,881	44,898	12,327

Table 24. Acres of affected park land where vehicles would be audible by road segment, Alternative 1b, worst case conditions

Alternative 1b Worst case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	16,126	5,445	0	16,822	6,342	0
2. Mammoth to Norris	5,044	0	0	5,356	0	0
3. West Entrance to Madison	4,425	2,374	0	4,676	2,652	0
4. Madison to Norris	3,955	156	0	4,161	177	0
5. Norris to Canyon Village	2,633	0	0	2,823	0	0
6. Canyon Village to Fishing Bridge	4,187	0	0	4,422	0	0
7. Fishing Bridge to East Entrance	6,463	0	0	6,856	0	0
8. Fishing Bridge to West Thumb	6,223	0	0	6,526	0	0
9. Madison to Old Faithful	5,156	1,563	0	5,462	2,048	0
10. Old Faithful to West Thumb	4,664	0	0	4,916	0	0
11. West Thumb to Flagg Ranch	5,725	0	0	6,102	108	0
12. Grassy Lake Road	1,841	0	0	1,951	0	0
13. Flagg Ranch to Colter Bay	4,508	0	0	4,748	255	0
14. Colter Bay to Moran Junction	4,579	1,825	0	4,926	2,040	0
15. Moran Junction to East Entrance	1,193	707	474	1,294	774	517
16. Moran Junction to South Entrance	21,714	14,425	11,108	23,842	16,777	11,810
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	9,124	0	0	9,548	0	0
Total	107,561	26,495	11,582	114,432	31,173	12,327

Table 25. Acres of affected park land where vehicles would be audible by road segment, Alternative 2, worst case conditions

Alternative 2 Worst case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	16,126	5,445	0	16,822	6,342	0
2. Mammoth to Norris	5,210	550	0	5,569	647	0
3. West Entrance to Madison	5,489	4,302	2,682	5,887	4,777	3,270
4. Madison to Norris	3,898	2,692	0	4,205	3,061	85
5. Norris to Canyon Village	3,178	2,029	0	3,447	2,324	0
6. Canyon Village to Fishing Bridge	4,843	2,712	0	5,176	3,086	0
7. Fishing Bridge to East Entrance	7,997	4,482	0	8,577	5,199	0
8. Fishing Bridge to West Thumb	7,166	4,398	0	7,578	4,863	0
9. Madison to Old Faithful	6,491	4,961	3,115	6,961	5,516	3,764
10. Old Faithful to West Thumb	4,503	3,007	0	4,885	3,438	0
11. West Thumb to Flagg Ranch	7,119	4,948	493	7,658	5,575	595
12. Grassy Lake Road	1,915	272	0	2,084	311	0
13. Flagg Ranch to Colter Bay	4,558	1,176	0	4,887	1,346	0
14. Colter Bay to Moran Junction	4,585	2,368	0	4,933	2,568	0
15. Moran Junction to East Entrance	1,203	729	496	1,306	839	542
16. Moran Junction to South Entrance	21,714	14,425	11,108	23,842	16,631	11,731
17. Jackson Lake Area	4,855	0	0	5,132	0	0
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	9,124	0	0	9,548	0	0
Total	119,975	58,497	17,894	128,495	66,522	19,987

Table 26. Acres of affected park land where vehicles would be audible by road segment, Alternative 3, worst case conditions

Alternative 3 Worst case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	16,126	5,445	0	16,822	6,342	0
2. Mammoth to Norris	9,471	6,301	116	9,847	6,759	550
3. West Entrance to Madison	5,913	4,677	729	6,117	4,887	1,202
4. Madison to Norris	5,674	4,568	288	5,862	4,783	311
5. Norris to Canyon Village	4,475	3,296	0	4,605	3,448	0
6. Canyon Village to Fishing Bridge	7,683	4,929	0	8,059	5,370	0
7. Fishing Bridge to East Entrance	12,309	8,366	787	12,804	8,953	1,042
8. Fishing Bridge to West Thumb	11,959	7,268	0	12,646	7,567	0
9. Madison to Old Faithful	7,940	6,437	4,710	8,209	6,750	5,052
10. Old Faithful to West Thumb	6,341	5,023	0	6,526	5,213	0
11. West Thumb to Flagg Ranch	12,857	10,215	7,544	13,363	10,801	8,109
12. Grassy Lake Road	2,982	1,927	0	3,128	2,024	0
13. Flagg Ranch to Colter Bay	7,234	4,675	0	7,669	4,876	0
14. Colter Bay to Moran Junction	4,768	2,948	461	5,086	3,109	579
15. Moran Junction to East Entrance	1,265	917	544	1,353	1,019	591
16. Moran Junction to South Entrance	21,714	14,425	11,108	23,842	16,777	11,810
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	9,124	0	0	9,548	0	0
Total	147,834	91,417	26,287	155,488	98,680	29,246

Table 27. Acres of affected park land where vehicles would be audible by road segment, Alternative 4, worst case conditions

Alternative 4 Worst case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	16,126	5,445	0	16,822	6,342	0
2. Mammoth to Norris	8,020	5,169	0	8,395	5,435	0
3. West Entrance to Madison	6,526	5,565	4,230	6,873	5,977	4,724
4. Madison to Norris	5,642	4,558	283	5,826	4,771	307
5. Norris to Canyon Village	4,476	3,467	0	4,607	3,599	0
6. Canyon Village to Fishing Bridge	8,178	4,966	0	8,561	5,418	0
7. Fishing Bridge to East Entrance	12,309	8,435	857	12,804	9,018	1,104
8. Fishing Bridge to West Thumb	11,959	7,307	0	12,646	7,607	0
9. Madison to Old Faithful	7,954	6,699	5,114	8,395	7,216	5,700
10. Old Faithful to West Thumb	6,341	5,043	0	6,526	5,240	0
11. West Thumb to Flagg Ranch	11,359	8,763	1,585	11,868	9,212	2,371
12. Grassy Lake Road	2,974	679	0	3,119	892	0
13. Flagg Ranch to Colter Bay	7,206	2,555	0	7,638	2,955	0
14. Colter Bay to Moran Junction	4,715	2,822	0	5,041	2,976	91
15. Moran Junction to East Entrance	1,250	854	525	1,352	955	569
16. Moran Junction to South Entrance	21,714	14,425	11,108	23,842	16,777	11,810
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	9,124	0	0	9,548	0	0
Total	145,874	86,751	23,702	153,864	94,390	26,676

Table 28. Acres of affected park land where vehicles would be audible by road segment, Alternative 1a, best case conditions

Alternative 1a Best case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	6,036	0	0	6,056	0	0
2. Mammoth to Norris	2,863	0	0	2,986	0	0
3. West Entrance to Madison	1,726	24	0	1,799	35	0
4. Madison to Norris	1,743	0	0	1,789	0	0
5. Norris to Canyon Village	1,423	0	0	1,448	0	0
6. Canyon Village to Fishing Bridge	2,413	0	0	2,555	0	0
7. Fishing Bridge to East Entrance	3,711	0	0	3,876	0	0
8. Fishing Bridge to West Thumb	3,656	0	0	3,947	0	0
9. Madison to Old Faithful	2,032	0	0	2,127	0	0
10. Old Faithful to West Thumb	2,016	0	0	2,051	0	0
11. West Thumb to Flagg Ranch	3,139	0	0	3,251	0	0
12. Grassy Lake Road	1,062	0	0	1,111	0	0
13. Flagg Ranch to Colter Bay	2,543	0	0	2,722	0	0
14. Colter Bay to Moran Junction	1,329	45	0	1,335	47	0
15. Moran Junction to East Entrance	298	226	14	300	226	14
16. Moran Junction to South Entrance	4,708	3,106	450	4,749	3,108	470
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	3,430	0	0	3,433	0	0
Total	44,128	3,401	464	45,538	3,417	485

Table 29. Acres of affected park land where vehicles would be audible by road segment, Alternative 1b, best case conditions

Alternative 1b Best case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	6,036	0	0	6,056	0	0
2. Mammoth to Norris	2,116	0	0	2,195	0	0
3. West Entrance to Madison	1,467	0	0	1,503	0	0
4. Madison to Norris	1,479	0	0	1,520	0	0
5. Norris to Canyon Village	1,166	0	0	1,188	0	0
6. Canyon Village to Fishing Bridge	1,660	0	0	1,744	0	0
7. Fishing Bridge to East Entrance	2,727	0	0	2,832	0	0
8. Fishing Bridge to West Thumb	2,279	0	0	2,441	0	0
9. Madison to Old Faithful	1,701	0	0	1,752	0	0
10. Old Faithful to West Thumb	1,756	0	0	1,789	0	0
11. West Thumb to Flagg Ranch	2,391	0	0	2,468	0	0
12. Grassy Lake Road	771	0	0	802	0	0
13. Flagg Ranch to Colter Bay	1,657	0	0	1,761	0	0
14. Colter Bay to Moran Junction	1,329	45	0	1,335	47	0
15. Moran Junction to East Entrance	298	226	14	300	226	14
16. Moran Junction to South Entrance	4,708	3,106	450	4,749	3,108	470
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	3,430	0	0	3,433	0	0
Total	36,971	3,377	464	37,868	3,382	485

Table 30. Acres of affected park land where vehicles would be audible by road segment, Alternative 2, best case conditions

Alternative 2 Best case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	6,036	0	0	6,056	0	0
2. Mammoth to Norris	2,428	0	0	2,841	0	0
3. West Entrance to Madison	1,726	1,547	46	2,127	1,648	308
4. Madison to Norris	1,662	1,523	0	1,874	1,668	0
5. Norris to Canyon Village	1,381	0	0	1,499	420	0
6. Canyon Village to Fishing Bridge	2,104	262	0	2,580	677	0
7. Fishing Bridge to East Entrance	3,407	281	0	4,027	728	0
8. Fishing Bridge to West Thumb	3,026	584	0	4,003	1,519	0
9. Madison to Old Faithful	2,038	1,787	105	2,510	1,929	422
10. Old Faithful to West Thumb	1,957	0	0	2,124	682	0
11. West Thumb to Flagg Ranch	2,946	2,648	0	3,423	3,017	0
12. Grassy Lake Road	954	0	0	1,058	0	0
13. Flagg Ranch to Colter Bay	2,230	0	0	2,567	0	0
14. Colter Bay to Moran Junction	1,402	1,088	0	1,513	1,100	0
15. Moran Junction to East Entrance	315	227	14	358	251	15
16. Moran Junction to South Entrance	4,708	3,106	450	4,749	3,108	470
17. Jackson Lake Area	2,443	0	0	2,902	0	0
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	3,430	0	0	3,433	0	0
Total	44,194	13,051	615	49,644	16,749	1,215

Table 31. Acres of affected park land where vehicles would be audible by road segment, Alternative 3, best case conditions

Alternative 3 Best case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	6,036	0	0	6,056	0	0
2. Mammoth to Norris	2,531	203	0	2,742	358	0
3. West Entrance to Madison	1,562	1,440	0	1,634	1,507	0
4. Madison to Norris	1,582	1,448	0	1,664	1,525	0
5. Norris to Canyon Village	1,310	0	0	1,356	0	0
6. Canyon Village to Fishing Bridge	2,038	262	0	2,278	465	0
7. Fishing Bridge to East Entrance	3,273	281	0	3,555	497	0
8. Fishing Bridge to West Thumb	2,965	585	0	3,450	1,034	0
9. Madison to Old Faithful	1,908	1,694	54	2,013	1,778	95
10. Old Faithful to West Thumb	1,856	0	0	1,921	0	0
11. West Thumb to Flagg Ranch	2,981	2,552	147	3,189	2,753	260
12. Grassy Lake Road	851	80	0	938	142	0
13. Flagg Ranch to Colter Bay	1,888	347	0	2,201	614	0
14. Colter Bay to Moran Junction	1,330	1,059	0	1,401	1,080	0
15. Moran Junction to East Entrance	298	227	14	316	230	15
16. Moran Junction to South Entrance	4,708	3,106	450	4,749	3,108	470
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	3,430	0	0	3,433	0	0
Total	40,549	13,283	664	42,896	15,091	839

Table 32. Acres of affected park land where vehicles would be audible by road segment, Alternative 4, best case conditions

Alternative 4 Best case conditions	Acres of Affected Park Land where vehicles are audible					
	Average Background			Quiet Background		
Road Segment	Audible at All	Audible 10% or more	Audible 50% or more	Audible at All	Audible 10% or more	Audible 50% or more
1. Mammoth to Northeast Entrance	6,036	0	0	6,056	0	0
2. Mammoth to Norris	2,324	187	0	2,540	330	0
3. West Entrance to Madison	1,628	1,455	36	1,724	1,540	57
4. Madison to Norris	1,582	1,448	0	1,664	1,525	0
5. Norris to Canyon Village	1,310	0	0	1,356	0	0
6. Canyon Village to Fishing Bridge	2,042	263	0	2,284	465	0
7. Fishing Bridge to East Entrance	3,273	283	0	3,555	501	0
8. Fishing Bridge to West Thumb	2,965	585	0	3,450	1,035	0
9. Madison to Old Faithful	1,915	1,688	81	2,051	1,811	131
10. Old Faithful to West Thumb	1,856	0	0	1,921	0	0
11. West Thumb to Flagg Ranch	2,823	2,528	0	3,026	2,720	0
12. Grassy Lake Road	851	0	0	938	0	0
13. Flagg Ranch to Colter Bay	1,888	0	0	2,201	0	0
14. Colter Bay to Moran Junction	1,330	1,059	0	1,401	1,073	0
15. Moran Junction to East Entrance	298	226	14	315	227	15
16. Moran Junction to South Entrance	4,708	3,106	450	4,749	3,108	470
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	3,430	0	0	3,433	0	0
Total	40,260	12,827	581	42,664	14,336	673

5.4 Average Sound Levels

To permit an evaluation of the average magnitude of the noise from wheeled and over-snow vehicle traffic, the modeling effort included computations of the hourly equivalent or "average" sound level (L_{eq}) over the day. Levels are shown for the five alternatives in Table 33 through Table 42 for each road segment at two distances, 100 ft and 1000 ft, and for both open and forested terrain. First, tables of results are given for worst-case propagation conditions, followed by the results for the best-case propagation conditions.

These hourly L_{eq} values do not have the background sound level added into them. Also, they cannot be compared against the background levels to assess audibility, since L_{eq} represents a long-term average of both quiet and loud moments.

L_{eq} is an energy-based metric, so, if only a single snowmobile with a maximum level of 70 dBA passed by a site 100 feet from a trail during in an entire hour, the L_{eq} for that hour at that site would be approximately 40-45 dBA. If ten 70-dBA snowmobiles passed by instead of one, the L_{eq} would be 10 decibels higher, about 50-55 dBA.

The most notable conclusion that can be drawn by comparing results across alternatives is that L_{eq}s are significantly higher for the alternatives that include snowmobiles (2, 3, and 4) as compared with the alternatives that replace snowmobiles with snowcoaches (1a & 1b). The differences typically range from 8 dBA to 15 dBA, depending on road segment, alternative and distance.

Table 33. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 1a, worst case conditions

Alternative 1a Worst case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	35	13	33	5
2. Mammoth to Norris	37	11	35	3
3. West Entrance to Madison	48	22	46	14
4. Madison to Norris	44	19	42	11
5. Norris to Canyon Village	43	18	41	10
6. Canyon Village to Fishing Bridge	42	17	40	9
7. Fishing Bridge to East Entrance	36	11	34	3
8. Fishing Bridge to West Thumb	41	16	39	8
9. Madison to Old Faithful	47	22	45	14
10. Old Faithful to West Thumb	43	18	42	10
11. West Thumb to Flagg Ranch	43	18	41	10
12. Grassy Lake Road	35	11	34	3
13. Flagg Ranch to Colter Bay	43	18	41	10
14. Colter Bay to Moran Junction	40	18	38	10
15. Moran Junction to East Entrance	45	22	43	14
16. Moran Junction to South Entrance	46	24	44	16
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	24	2	22	0

Table 34. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 1b, worst case conditions

Alternative 1b Worst case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	35	13	33	5
2. Mammoth to Norris	34	6	32	0
3. West Entrance to Madison	44	17	42	8
4. Madison to Norris	41	13	39	5
5. Norris to Canyon Village	39	12	38	4
6. Canyon Village to Fishing Bridge	38	11	37	3
7. Fishing Bridge to East Entrance	32	4	30	0
8. Fishing Bridge to West Thumb	38	10	36	2
9. Madison to Old Faithful	44	16	42	8
10. Old Faithful to West Thumb	40	12	38	4
11. West Thumb to Flagg Ranch	39	12	37	4
12. Grassy Lake Road	31	3	29	0
13. Flagg Ranch to Colter Bay	39	12	37	4
14. Colter Bay to Moran Junction	40	18	38	10
15. Moran Junction to East Entrance	45	22	43	14
16. Moran Junction to South Entrance	46	24	44	16
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	24	2	22	0

Table 35. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 2, worst case conditions

Alternative 2 Worst case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	35	13	33	5
2. Mammoth to Norris	46	12	45	4
3. West Entrance to Madison	56	25	54	16
4. Madison to Norris	54	20	52	11
5. Norris to Canyon Village	53	18	51	10
6. Canyon Village to Fishing Bridge	52	17	50	9
7. Fishing Bridge to East Entrance	52	18	51	10
8. Fishing Bridge to West Thumb	51	17	49	8
9. Madison to Old Faithful	56	24	54	16
10. Old Faithful to West Thumb	53	19	51	10
11. West Thumb to Flagg Ranch	54	20	53	12
12. Grassy Lake Road	48	14	46	5
13. Flagg Ranch to Colter Bay	48	14	46	5
14. Colter Bay to Moran Junction	49	19	47	11
15. Moran Junction to East Entrance	50	23	48	15
16. Moran Junction to South Entrance	46	24	44	16
17. Jackson Lake Area	45	11	44	3
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	24	2	22	0

Table 36. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 3, worst case conditions

Alternative 3 Worst case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	35	13	33	5
2. Mammoth to Norris	50	20	48	12
3. West Entrance to Madison	52	23	51	15
4. Madison to Norris	51	22	50	14
5. Norris to Canyon Village	50	21	48	12
6. Canyon Village to Fishing Bridge	49	20	47	12
7. Fishing Bridge to East Entrance	50	20	48	12
8. Fishing Bridge to West Thumb	48	19	47	11
9. Madison to Old Faithful	54	25	53	17
10. Old Faithful to West Thumb	50	21	49	13
11. West Thumb to Flagg Ranch	54	25	52	17
12. Grassy Lake Road	47	17	45	9
13. Flagg Ranch to Colter Bay	47	17	45	9
14. Colter Bay to Moran Junction	47	21	46	12
15. Moran Junction to East Entrance	49	24	47	16
16. Moran Junction to South Entrance	46	24	44	16
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	24	2	22	0

Table 37. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 4, worst case conditions

Alternative 4 Worst case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	35	13	33	5
2. Mammoth to Norris	47	17	45	9
3. West Entrance to Madison	54	26	53	18
4. Madison to Norris	51	22	50	14
5. Norris to Canyon Village	50	21	48	13
6. Canyon Village to Fishing Bridge	49	20	47	12
7. Fishing Bridge to East Entrance	50	20	48	12
8. Fishing Bridge to West Thumb	48	19	47	11
9. Madison to Old Faithful	54	26	53	18
10. Old Faithful to West Thumb	51	21	49	13
11. West Thumb to Flagg Ranch	52	23	50	15
12. Grassy Lake Road	45	16	44	8
13. Flagg Ranch to Colter Bay	45	16	44	8
14. Colter Bay to Moran Junction	46	20	45	12
15. Moran Junction to East Entrance	48	23	46	15
16. Moran Junction to South Entrance	46	24	44	16
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	24	2	22	0

Table 38. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 1a, best case conditions

Alternative 1a Best case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	34	1	32	0
2. Mammoth to Norris	36	0	35	0
3. West Entrance to Madison	47	8	46	0
4. Madison to Norris	44	5	42	0
5. Norris to Canyon Village	43	4	41	0
6. Canyon Village to Fishing Bridge	42	3	40	0
7. Fishing Bridge to East Entrance	35	0	34	0
8. Fishing Bridge to West Thumb	41	2	39	0
9. Madison to Old Faithful	47	8	45	0
10. Old Faithful to West Thumb	43	4	41	0
11. West Thumb to Flagg Ranch	43	4	41	0
12. Grassy Lake Road	35	0	33	0
13. Flagg Ranch to Colter Bay	43	4	41	0
14. Colter Bay to Moran Junction	39	6	37	2
15. Moran Junction to East Entrance	44	11	42	6
16. Moran Junction to South Entrance	45	12	43	8
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	23	0	21	0

Table 39. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 1b, best case conditions

Alternative 1b Best case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	34	1	32	0
2. Mammoth to Norris	33	0	32	0
3. West Entrance to Madison	44	5	42	0
4. Madison to Norris	40	1	39	0
5. Norris to Canyon Village	39	0	37	0
6. Canyon Village to Fishing Bridge	38	0	36	0
7. Fishing Bridge to East Entrance	31	0	30	0
8. Fishing Bridge to West Thumb	37	0	36	0
9. Madison to Old Faithful	43	4	42	0
10. Old Faithful to West Thumb	40	0	38	0
11. West Thumb to Flagg Ranch	39	0	37	0
12. Grassy Lake Road	30	0	29	0
13. Flagg Ranch to Colter Bay	39	0	37	0
14. Colter Bay to Moran Junction	39	6	37	2
15. Moran Junction to East Entrance	44	11	42	6
16. Moran Junction to South Entrance	45	12	43	8
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh
19. Moose-Wilson Road	23	0	21	0

Table 40. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 2, best case conditions

Alternative 2 Best case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	34	1	32	0
2. Mammoth to Norris	44	3	45	0
3. West Entrance to Madison	56	17	54	8
4. Madison to Norris	51	11	52	4
5. Norris to Canyon Village	50	10	51	3
6. Canyon Village to Fishing Bridge	49	9	50	2
7. Fishing Bridge to East Entrance	50	9	51	3
8. Fishing Bridge to West Thumb	48	8	49	2
9. Madison to Old Faithful	56	17	54	8
10. Old Faithful to West Thumb	50	10	51	4
11. West Thumb to Flagg Ranch	51	11	53	5
12. Grassy Lake Road	48	8	46	0
13. Flagg Ranch to Colter Bay	48	8	46	0
14. Colter Bay to Moran Junction	48	10	47	3
15. Moran Junction to East Entrance	49	13	48	7
16. Moran Junction to South Entrance	45	12	43	8
17. Jackson Lake Area	45	5	44	0
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	23	0	21	0

Table 41. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 3, best case conditions

Alternative 3 Best case conditions	Leq at Distance [dBA]			
Road Segment	Open Terrain		Forested Terrain	
	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	34	1	32	0
2. Mammoth to Norris	49	9	48	0
3. West Entrance to Madison	52	12	50	3
4. Madison to Norris	51	11	49	2
5. Norris to Canyon Village	50	10	48	0
6. Canyon Village to Fishing Bridge	49	9	47	0
7. Fishing Bridge to East Entrance	50	9	48	0
8. Fishing Bridge to West Thumb	48	8	46	0
9. Madison to Old Faithful	54	14	52	5
10. Old Faithful to West Thumb	50	10	49	1
11. West Thumb to Flagg Ranch	54	14	52	4
12. Grassy Lake Road	46	6	45	0
13. Flagg Ranch to Colter Bay	46	6	45	0
14. Colter Bay to Moran Junction	47	9	45	3
15. Moran Junction to East Entrance	48	12	47	7
16. Moran Junction to South Entrance	45	12	43	8
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	23	0	21	0

Table 42. Average hourly Leq from vehicular noise at two distances from each road segment, Alternative 4, best case conditions

Alternative 4 Best case conditions	Leq at Distance [dBA]			
	Open Terrain		Forested Terrain	
Road Segment	100 ft	1000 ft	100 ft	1000 ft
1. Mammoth to Northeast Entrance	34	1	32	0
2. Mammoth to Norris	46	6	45	0
3. West Entrance to Madison	54	15	52	5
4. Madison to Norris	51	11	49	2
5. Norris to Canyon Village	50	10	48	0
6. Canyon Village to Fishing Bridge	49	9	47	0
7. Fishing Bridge to East Entrance	50	9	48	0
8. Fishing Bridge to West Thumb	48	8	47	0
9. Madison to Old Faithful	54	15	52	5
10. Old Faithful to West Thumb	50	10	49	1
11. West Thumb to Flagg Ranch	52	12	50	2
12. Grassy Lake Road	45	5	43	0
13. Flagg Ranch to Colter Bay	45	5	43	0
14. Colter Bay to Moran Junction	46	9	44	3
15. Moran Junction to East Entrance	47	12	46	7
16. Moran Junction to South Entrance	45	12	43	8
17. Jackson Lake Area	No Veh.	No Veh.	No Veh.	No Veh.
18. Teton Park Road	No Veh.	No Veh.	No Veh.	No Veh.
19. Moose-Wilson Road	23	0	21	0